CIVILIAN CONSERVATION CORPS

FORESTRY PUBLICATION No. 5

COLLECTING AND HANDLING SEEDS OF WILD PLANTS

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By N. T. MIROV, *Associate Conservationist*
and CHARLES J. KRAEBEL, *Principal Silviculturist*
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

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California Forest and Range Experiment Station

Forest Service

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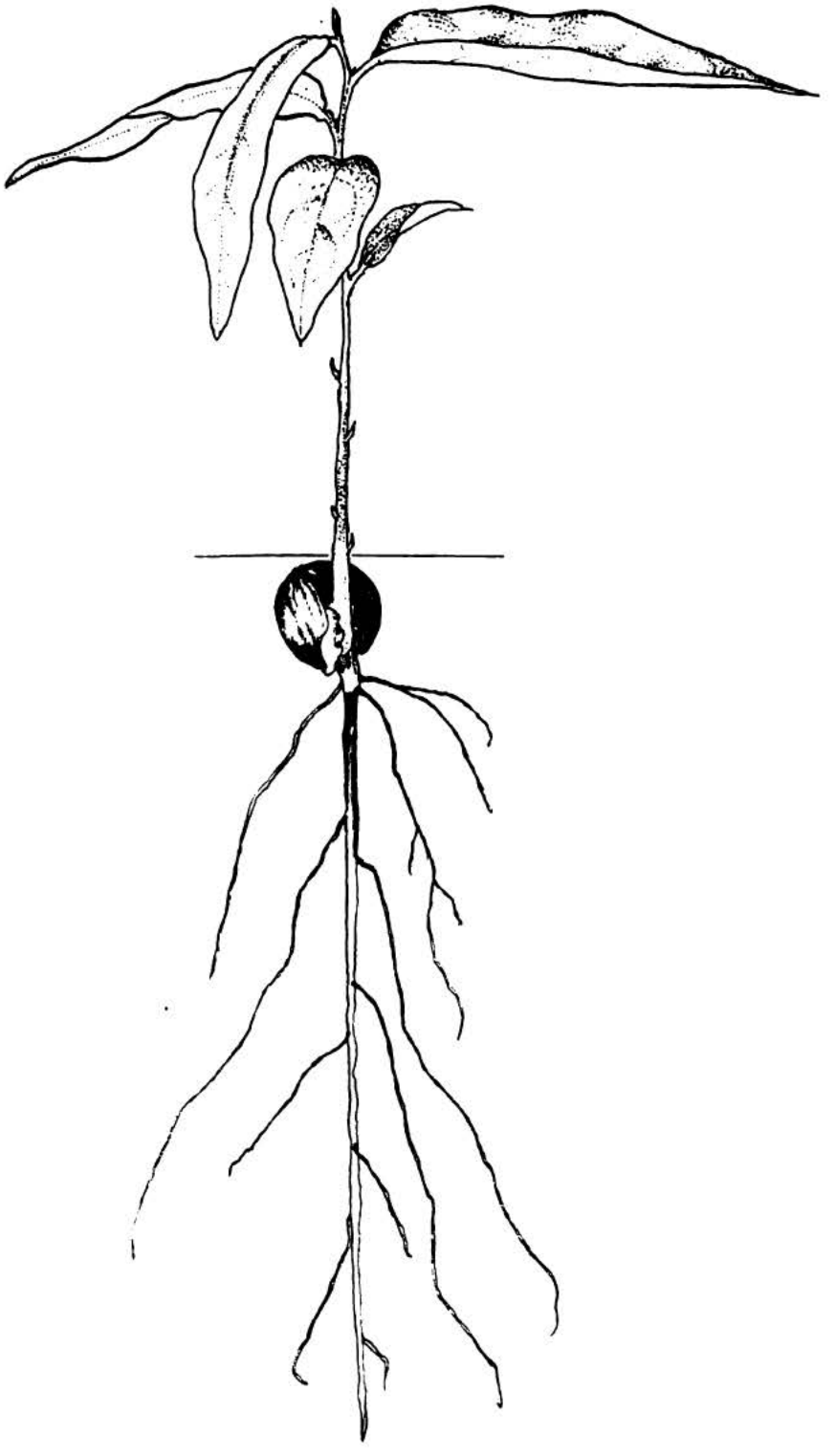

A healthy seedling of California laurel (*Umbellularia californica*) germinated in peat and ready to be transplanted into a 1-gallon can. (Original drawing.)

COLLECTING AND HANDLING SEEDS OF WILD PLANTS

By N. T. MIROV, *Associate Conservationist*, and CHARLES J. KRAEBEL, *Principal Silviculturist, California Forest and Range Experiment Station, Forest Service, United States Department of Agriculture.*

INTRODUCTION

This manual for the Civilian Conservation Corps has two purposes. First, it is intended to give information regarding collecting, storing, and propagating seeds of wild plants that may be useful in various conservation projects. Wild plants can be used in erosion and flood control; in planting road cuts and fills; in revegetating burned areas; in providing food for game; in landscaping public campgrounds, forest-ranger stations, C. C. C. camps, and similar areas.

The second purpose of the manual is to help those C. C. C. enrollees who have become interested in wild flowers and shrubs as a hobby or even as a possible source of income in civilian life.

Wild plants are becoming more popular for horticultural purposes, but their possibilities are not as yet fully appreciated. The Western States are especially rich in flowering shrubs and brightly colored flowers. Some of them, such as penstemons, snapdragons, or poppies, already occupy a prominent place in American and European gardens and have been the origin of numerous cultivated varieties. Many others still await their introduction to the world. Some little-known wild lilacs having deep ultramarine-blue flowers, Mariposa lilies, and lupines are among the many possibilities of the wild vegetation of the Western States. However, such factors as the increasing population, the better roads now connecting cities and countryside, fires, and grazing are bringing about changes in our native vegetation with such rapidity that some plants which have grown in abundance are now becoming rare and are even disappearing entirely.

When properly collected and handled, a few seeds from many of the rare species will produce numerous plants. Some commercial nurseries now specialize in selling native plants for gardens, and a few companies sell the seeds of wild plants. In both plants and seeds there is a fairly large volume of trade. Unfortunately, very little information is available about the raising of wild plants. Although there are many books regarding the growing of cultivated plants, such as roses or gladiolus, very little is published about the growing of wild plants. This manual is intended partly to fill such a need.

Not long ago the object of forestry was pretty generally considered to be the growing of timber, and forest planting was con-

cerned chiefly with lumber-producing trees. In recent years the field of forestry has grown to include the other uses of the forest, such as grazing, recreation, stream-flow regulation, erosion control, and the preservation of scenic beauty.

Today forestry is as much concerned with the protection and culture of shrubs, herbs, and grasses as of trees. In the mountains of southern California or Arizona, for example, millions of acres of watershed are completely covered with chaparral, a dwarf forest of shrubs, which is important in controlling run-off and erosion. In the artificial replanting of bare areas with chaparral, in the planting of the bare sides of newly built roads through national forests, in the improvement of campgrounds and other recreational areas or of forest-ranger stations, shrubs, herbs, and grasses may be used instead of trees or with trees.

Modern forestry therefore requires practical knowledge of this lesser vegetation, how the various species grow and reproduce in nature, and how they may be reproduced artificially. Are seed crops abundant; is the harvesting simple and cheap or difficult and costly; can the seed be stored or must it be sown at once; will it germinate readily or are special treatments required? If nursery propagation proves necessary, what technique should be followed; can stock be planted with bare roots or must the plants be tenderly nursed in pots to a suitable size? Answers to such questions must be found for hundreds of native species before they can be successfully and economically used in the new forest management.

The answers to such questions, even for a single State, are learned very slowly. This manual deals with only a small part of the western flora—253 species. Some plants have been chosen because of their importance for erosion-control work; others for their ornamental value. This publication deals chiefly with plants growing in California, but since many of these plants grow beyond the boundaries of California, and since the general principles of handling the seed of wild plants are the same everywhere, the information presented here may be of use in other parts of the country, especially in the Western States.

LEARNING ABOUT WILD PLANTS

An intelligent person who lives or works in a certain region can readily observe that not all wild plants are alike. Some of them have showy flowers; others are more modest, but their foliage covers the ground like a mat. Some plants prefer moist places, and others thrive in barren ground where nothing else will grow. By merely observing native vegetation one learns which plants can be used for ornamental purposes and which have value for erosion control or for windbreak planting. When the observer becomes better acquainted with the local vegetation, he will notice that some plants do not produce seed in abundance every year; that there are lean years

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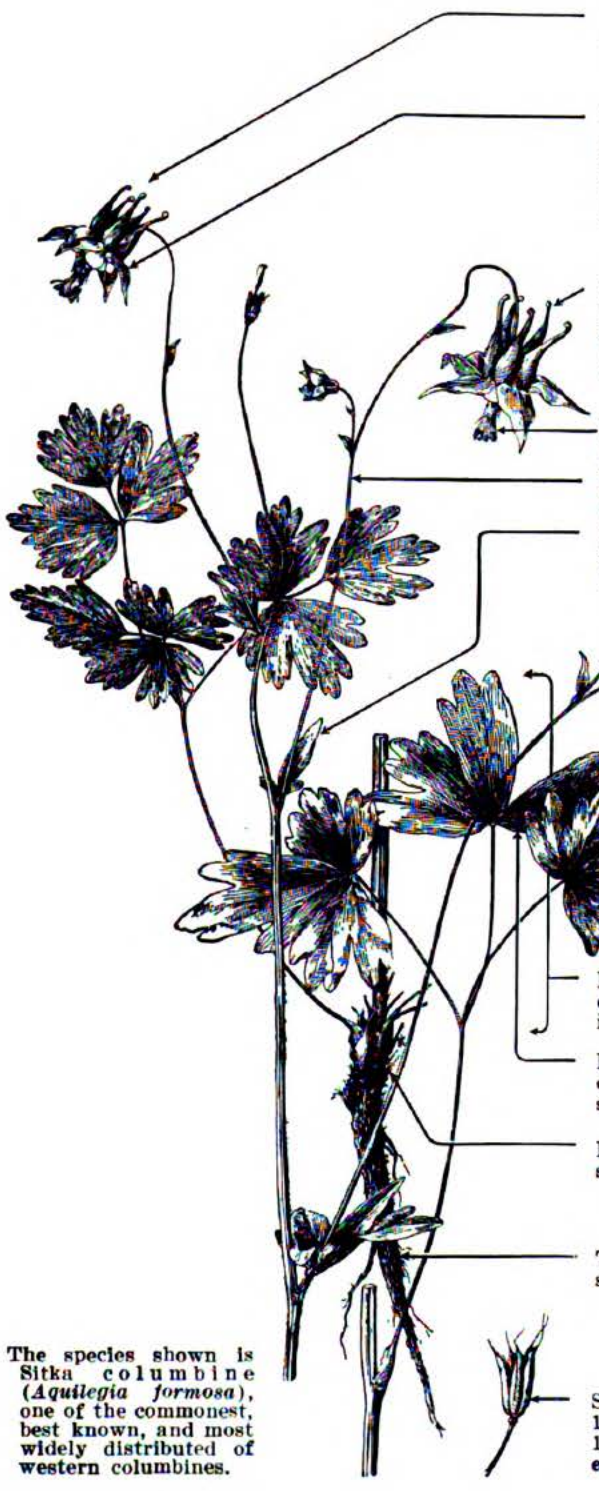
Sitka columbine (*Aquilegia formosa*). Note the seed pods, in which numerous black shiny seeds are found. The pods are collected before they are completely open and the seeds are extracted afterwards. (The opposed illustration and others of the same order that follow are taken from "The Range Plant Handbook," for which see Appendix I.)

COLUMBINES

Aquile'gia spp.



Flowers—showy, nodding, solitary

Outer flower parts (sepals)—5, alternating with petals, spreading or bent-back, up to 1 in. long, about equal in length to the elongated, hooked-tip petal bases (spurs)

Petals—5, equal, prolonged backward or upward into red spurs, and forward or downward into yellow blades up to ¼ in. long

Stamens — numerous, longer than petal blades

Stems—branching, erect, hairless below, sticky-hairy above

Upper leaves—reduced to simple, stalkless bracts or with 3 leaflets

Lower leaves — long-stalked, each with the 3 divisions bearing 3 leaflets

Leaflets—wedge-shaped, variously 3- to 5-cleft, hairless to somewhat hairy

Root crown—covered with persistent bases of old leafstalks

Taproot — fleshy, spindle-shaped, simple or branched

Seed pods (follicles)—5, up to 1 in. long, each splitting along 1 side, and tipped by a persistent threadlike stalk (style)

The species shown is Sitka columbine (*Aquilegia formosa*), one of the commonest, best known, and most widely distributed of western columbines.

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and years of plenty. He may observe that certain plants bloom and bear seeds profusely only when the preceding winter was unusually cold.

Questions about some of these facts can be easily answered, but others, as for instance the correct names of the plants or their general distribution, can be answered only by reading books on the subject or by consulting specialists in the field. A public library usually has one or more books describing native plants. In these books, some of which are listed in appendix 2, the wild plants are given in their proper order, and usually a key is provided for finding the correct name of the plant in question. Some puzzling questions about plants could be answered by a teacher of natural history in a nearby high school. If forest or ornamental nurseries are located nearby, these should be visited for first-hand information on the actual handling of nursery stock. A letter written to the nearest national forest supervisor, national park superintendent, or office of the Soil Conservation Service will bring an answer to questions connected with wild plants. Useful information can also be obtained from a State forester or from the extension service of a State university.

HANDLING SEEDS OF WILD PLANTS

COLLECTING

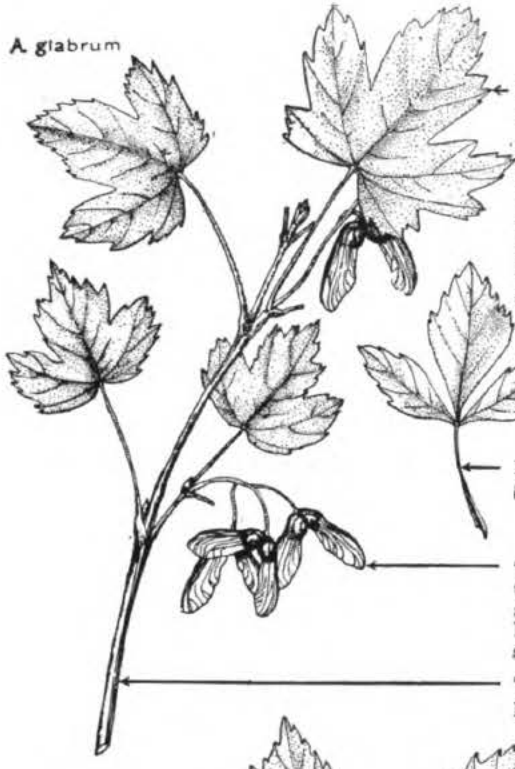
Seeds of a few wild plants can be purchased from commercial seedsmen, but many desirable species are not available from this source. Moreover, since dealers usually handle only small packages of wild seeds for amateur gardeners, their supplies are likely to be both too small and too costly for large-scale planting. The collection of seed by the C. C. C. organization itself may be necessary, and it is chiefly for guidance in gathering and handling the seed that the following notes are prepared.

In collecting seed the botanical identification of the mother plants is important. When a trained botanist is in charge of seed collecting, such identification is not difficult. Seed harvesting by a special crew, consisting of a botanist and one or two helpers, is costly and may usually be employed only for harvesting seeds of rare plants. When untrained men collect the seeds, however, one plant may be mistaken for another. To make it safer for such men to collect seeds, it would be advisable to build up a reference collection of known fruits and seed samples, under the supervision of a trained botanist. Most seeds for the collection could be kept in small glass vials. Only a few larger seeds, such as acorns or nuts, require larger containers. A seed collection of this kind is valuable in identifying different species. A further aid in the collection of uncommon species is the use of small-sized cards to which dried specimens of parts of plants are attached. If covered with transparent cellophane such cards can be used in the field without damage.

Rocky Mountain maple (*Acer glabrum*) and Douglas maple (*Acer douglasii*). Maple seeds (samaras) are collected from trees or from the ground and can be stored without removal of the wings.

ROCKY MOUNTAIN MAPLE

A'cer gla'brum, syns. *A. ne'o-mexica'num, A. triparti'tum*



ROCKY MOUNTAIN MAPLE

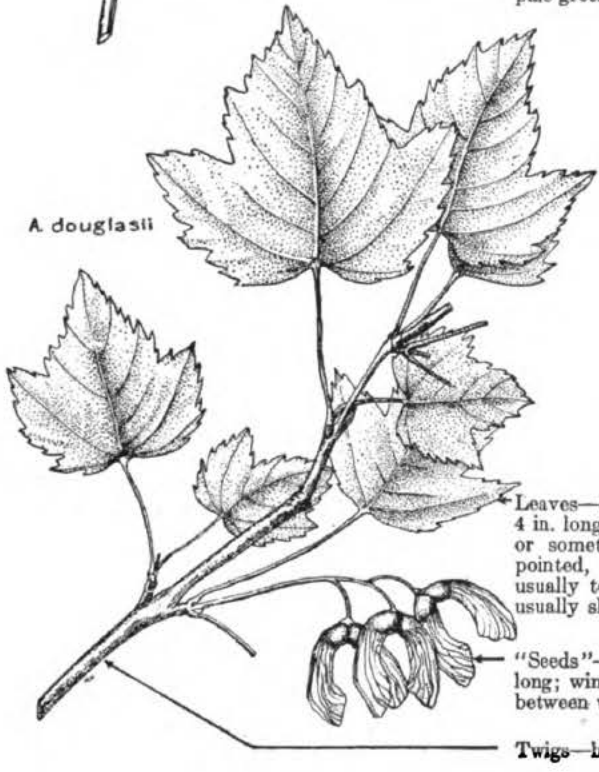
(*A. glabrum*)

Leaves—opposite, mostly hairless (glabrous), rounded in outline, 1 to 3 (sometimes up to 5) in. across, thin, dark green and lustrous above, paler below, often marked with red, 3- to 5-lobed, sometimes 3-parted to base; lobes pointed or blunt, with toothed edges, center lobe usually narrowed and entire below the middle; indentations (sinuses) between lobes usually deep and narrow

Leafstalk (petiole)—1 to 6 in. long, grooved, often bright red

"Seeds" (samaras)—paired, hairless, ¾ to 1¼ in. long; wings spreading at an acute or right angle, nearly straight on back, often rose-colored in summer; sinuses usually acute

Twigs—hairless, red, reddish brown or pale greenish brown



DOUGLAS MAPLE

(*A. douglasii*)

Leaves—opposite, hairless, thin, 1 to 4 in. long, about as wide, 3- to 5-lobed or sometimes 3-parted; lobes taper-pointed, sharply toothed on edges usually to base; sinuses between lobes usually shallow and open

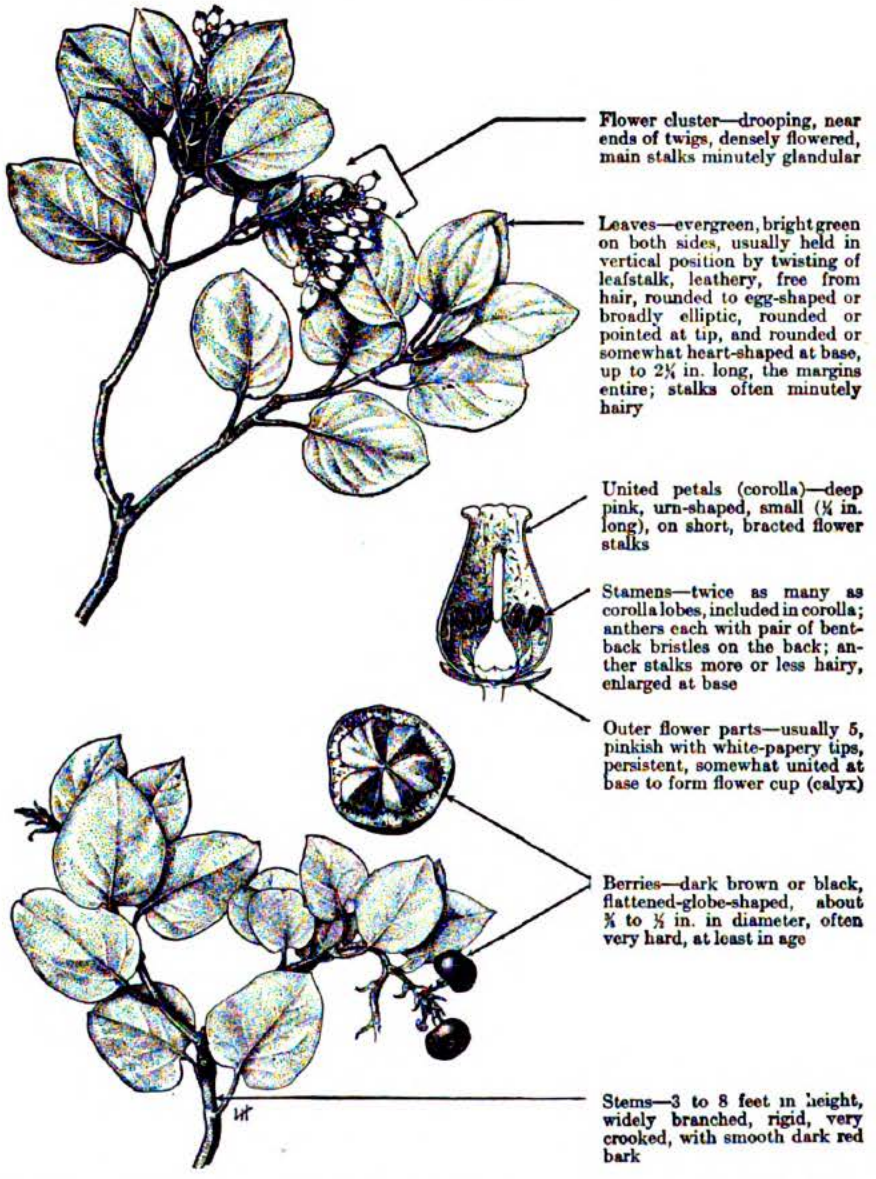
"Seeds"—paired, hairless, ¾ to 1½ in. long; wings incurved on back; sinuses between wings usually rounded

Twigs—hairless, purplish or red

It often happens that a desired plant grows in a remote or perhaps not easily accessible place, so that a special trip to that part of the country may be too expensive. The "wild lilac," *Ceanothus cyaneus*, for example, occurs naturally only in a few isolated canyons in San Diego County, Calif. Permission can sometimes be obtained to collect seeds of rare plants in public or private botanical gardens. Even the back yards of amateur gardeners may be seed-gathering grounds. Seeds of the above-mentioned wild lilac, for example, have been

GREENLEAF MANZANITA

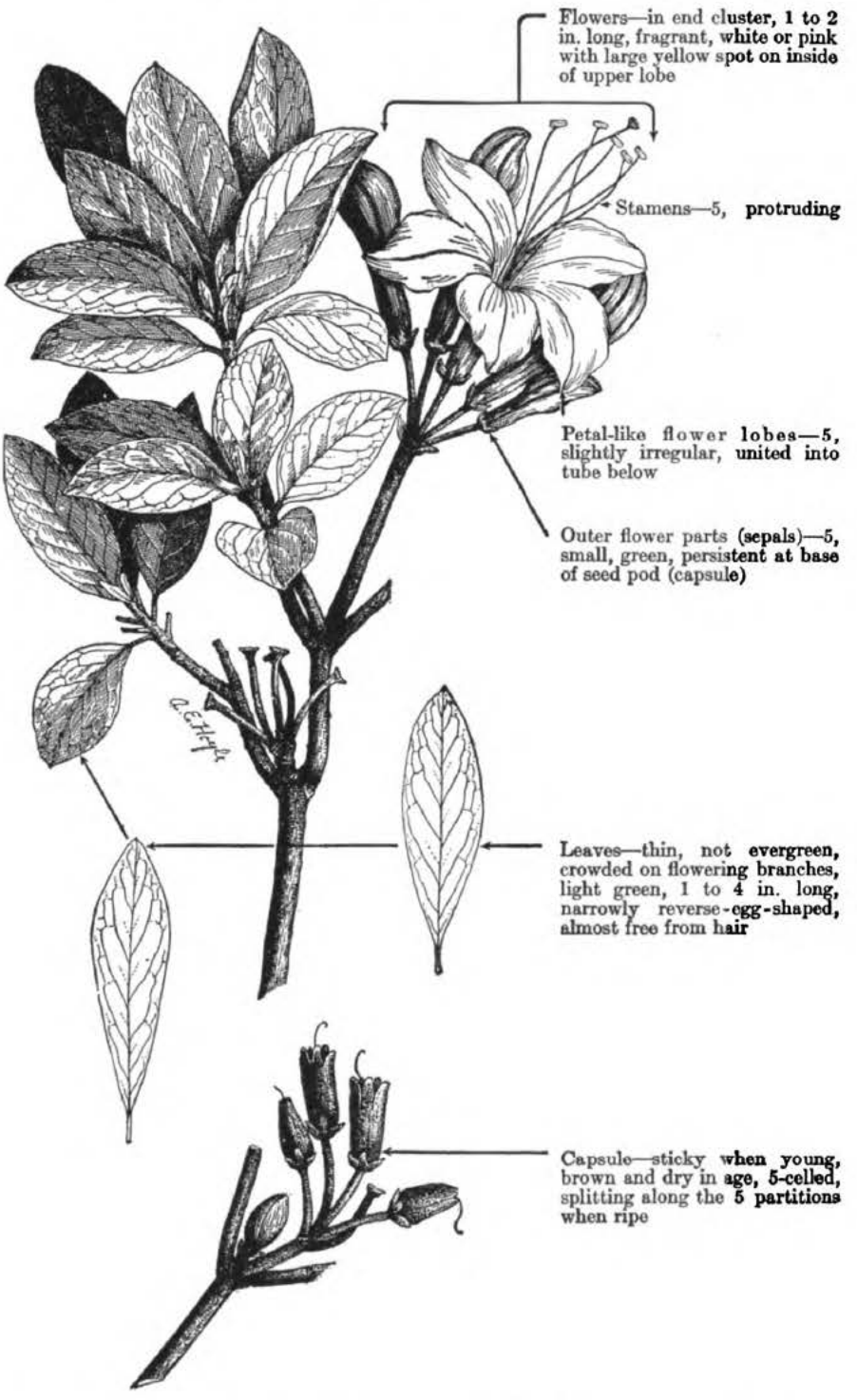
Arctosta'phylos pa'tula, syns. *A. platyphyl'la, A. pun'gens platyphyl'la*


Flower cluster—drooping, near ends of twigs, densely flowered, main stalks minutely glandular
Leaves—evergreen, bright green on both sides, usually held in vertical position by twisting of leafstalk, leathery, free from hair, rounded to egg-shaped or broadly elliptic, rounded or pointed at tip, and rounded or somewhat heart-shaped at base, up to 2½ in. long, the margins entire; stalks often minutely hairy
United petals (corolla)—deep pink, urn-shaped, small (¼ in. long), on short, bracted flower stalks
Stamens—twice as many as corolla lobes, included in corolla; anthers each with pair of bent-back bristles on the back; anther stalks more or less hairy, enlarged at base
Outer flower parts—usually 5, pinkish with white-papery tips, persistent, somewhat united at base to form flower cup (calyx)
Berries—dark brown or black, flattened-globe-shaped, about ⅜ to ½ in. in diameter, often very hard, at least in age
Stems—3 to 8 feet in height, widely branched, rigid, very crooked, with smooth dark red bark

Greenleaf manzanita (*Arctostaphylos patula*). Fruits of this plant are mealy berries containing very hard seeds that are difficult to germinate. The manzanitas can be propagated by cuttings.

WESTERN AZALEA

Aza'lea occidenta'lis, syn. *Rhododen'dron occidenta'le*


Flowers—in end cluster, 1 to 2 in. long, fragrant, white or pink with large yellow spot on inside of upper lobe
Stamens—5, protruding
Petal-like flower lobes—5, slightly irregular, united into tube below
Outer flower parts (sepals)—5, small, green, persistent at base of seed pod (capsule)
Leaves—thin, not evergreen, crowded on flowering branches, light green, 1 to 4 in. long, narrowly reverse-egg-shaped, almost free from hair
Capsule—sticky when young, brown and dry in age, 5-celled, splitting along the 5 partitions when ripe

Western azalea (*Azalea occidentalis*). Capsules contain numerous dustlike seeds (about 4 million per pound).

collected for several years from a large bush growing near the garage of a private residence. Shade trees on city streets and highways sometimes also afford an opportunity for seed gathering. In California, honey locust seeds have been regularly collected from planted trees along the streets of old mining towns. Elm, maple, and mountain ash have also been collected in this manner.

The practice of collecting seed of forest trees is well worked out and fully described in various forestry texts, such as C. C. C. Forestry. (See appendix 3.) Logging operations afford the cheapest way of collecting cones in large quantities. When a small amount of conifer seed is desired it may be convenient to collect cones from standing trees.

For certain species, or for continuing projects which require an annual supply of seed, a seed farm or wild-plant nursery may be established where desirable plants can be grown and the seed most conveniently gathered. This applies particularly to rare species such as *Carpentera californica* (for common names of plants, see appendix 1), and to plants whose seeds ripen and scatter in a short time, such as the lupines. Species having dustlike seed, such as *Rhododendron* or *Philadelphus*, also can be grown well in the seed farm. A single bush of rhododendron planted in the seed farm would provide enough seed in 1 year to fill the needs of a large nursery for several years. On a small scale this seed-farm idea has been used in California with considerable success. (For suggestions on the establishment of a wild-plant nursery, see (p. 26.)

The time for collecting the seed of most species can be stated only generally. It varies from year to year and from place to place. Seeds of one species may be ready for collection in the southern part of the territory in which it grows while it is still blooming in the northern part. The same is true of the distribution of a species according to altitude.

Each species offers a problem of its own in seed gathering. For example, acorns or buckeye nuts and also winged fruits of elm or maple can be collected from the ground. *Sambucus* berries can best be gathered in the cluster with long-handled pruning shears. Hand snips are required to clip *Photinia* berries. In stripping a shrub of its fruit, care should be taken to avoid disfiguring the plant by breaking branches.

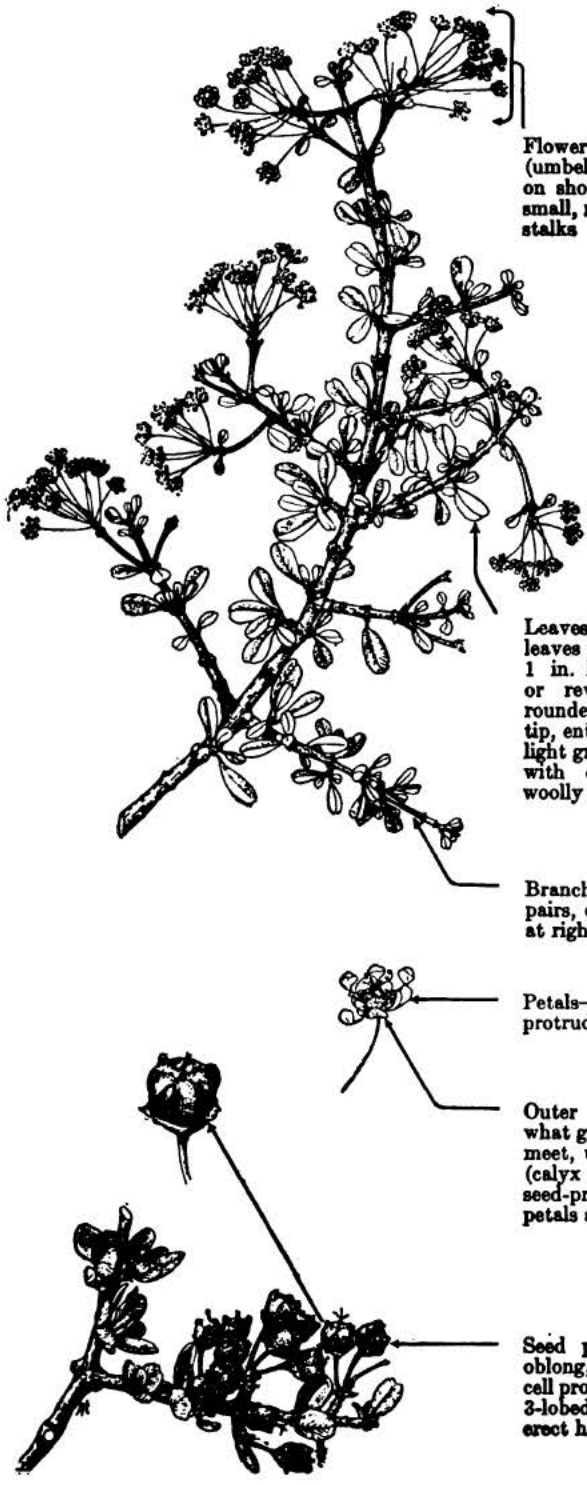
Cleaning of the seed should not be attempted in the field, except in the case of large seeds, such as acorns or chestnuts. As a rule, fruits (pods, capsules, or berries) rather than seeds should be gathered. The field equipment needed for seed collection should include:

1. Strong manila envelopes, 4 by 6 inches, with clip fasteners, for small lots of dry fruits and seeds.
2. Five-pound sugar sacks for large lots of dry seeds, and for small lots of large or pulpy fruits.
3. Large sugar sacks and gunny sacks for coarse seeds, cones, acorns, etc.

Wedgeleaf ceanothus (*Ceanothus cuneatus*). Dry seed pods of plants like this are crushed in a fruit disintegrator. Afterward the released seeds are separated from the chaff.

WEDGELEAF CEANOTHUS

Ceano'thus cunea'tus



Flower clusters—umbrella-shaped (umbellate), up to 1 in. broad, borne on short, spurlike branchlets; flowers small, numerous, dull white, on slender stalks

Leaves—opposite, often with smaller leaves in the axils, thick, small (up to 1 in. long), oblong or wedge-shaped or reversely egg-shaped, blunt or rounded with a slightly notched tip, entire or, very rarely, few-toothed, light green above, paler green beneath with extremely fine, matted, white-woolly hairs

Branches—widely spreading, mostly in pairs, often unequal in length, almost at right angles to the stems

Petals—5, long-clawed, hooded, with 5 protruding stamens opposite them

Outer flower parts (sepals)—5, somewhat greenish, bent inward so that tips meet, united below into a cuplike disk (calyx disk) to which the base of the seed-producing organ (ovary) and the petals and stamens are attached

Seed pod (capsule)—globe-shaped or oblong, about ¼ in. across, 3-celled, each cell producing one hard "seed" (nutlet), 3-lobed, each lobe with a conspicuous, erect horn on top

4. Tags of sized linen or tough cardboard for labeling sacked collections.

Every seed lot should be labeled by means of a substantial tag firmly tied to the sack. The label should show the scientific name, lot number, date, place of collection, altitude, weight when collected, and name of collector, all very plainly lettered with a soft (No. 2) lead pencil. A very hard pencil, indelible pencil, or ordinary writing ink, should never be used for labeling of seed lots. As an extra precaution it is advisable to place a second label, with the same information, *inside* the sack or envelope. This label should be of good-quality paper and should be folded face inward, or, if the seed is damp or pitchy, the label should be put inside an envelope to protect the data. When a collector is uncertain about the identity of the seed parent, it would be advisable to put a specimen of foliage, and flowers if they are still to be found, in the package with the seed.

In the case of low annual herbs and other species that are difficult to identify or even to find after the flowering stage is over, favorable seed-collecting sites must be located and the place marked while the plants are still in bloom.

It is better to collect most seeds when they are entirely ripe and dry. Exceptions to this rule are the poppies, some lupines, many of the *Ceanothi*, and other species with pod or capsule fruits that pop open suddenly when ripe and scatter their seeds widely. The fruits of such plants must be collected while they are still a little green; if left until quite dry the fruits split open at a touch and the seed is lost. In some localities fruits of this type can be collected best in the early morning while the plants are still moist with dew. The best time to collect seeds should be determined by frequent examination of the plants. When it is necessary to collect unripe fruits of species other than the popping types, they should be taken with pieces of stems or twigs attached. Taken in that manner, and not too green, such fruits will usually ripen when spread out in a dry and well-ventilated place. Indeed, it is said that the fruits of some plants, such as roses, should be gathered before they are entirely ripe, if quick germination of the seed is desired.

The seed ripening of many plants extends over a period of several weeks; hence if only one collection can be made it should be made when most of the seeds are ripening in order to get the largest harvest of good seed. Nevertheless, with poppies, perennial lupines, and some shrubs, several collections are almost always necessary.

EXTRACTING

All seeds should be thoroughly dried before being placed in storage. Exposure to direct sunlight in a well-ventilated greenhouse is sufficient to dry most seeds. Fruits of the "pop-open" type previously described should be spread thinly in trays and covered with cheesecloth, fine-mesh wire screen, or paper to prevent loss of seeds. Exposure to sunlight is helpful also in destroying insect larvae, which

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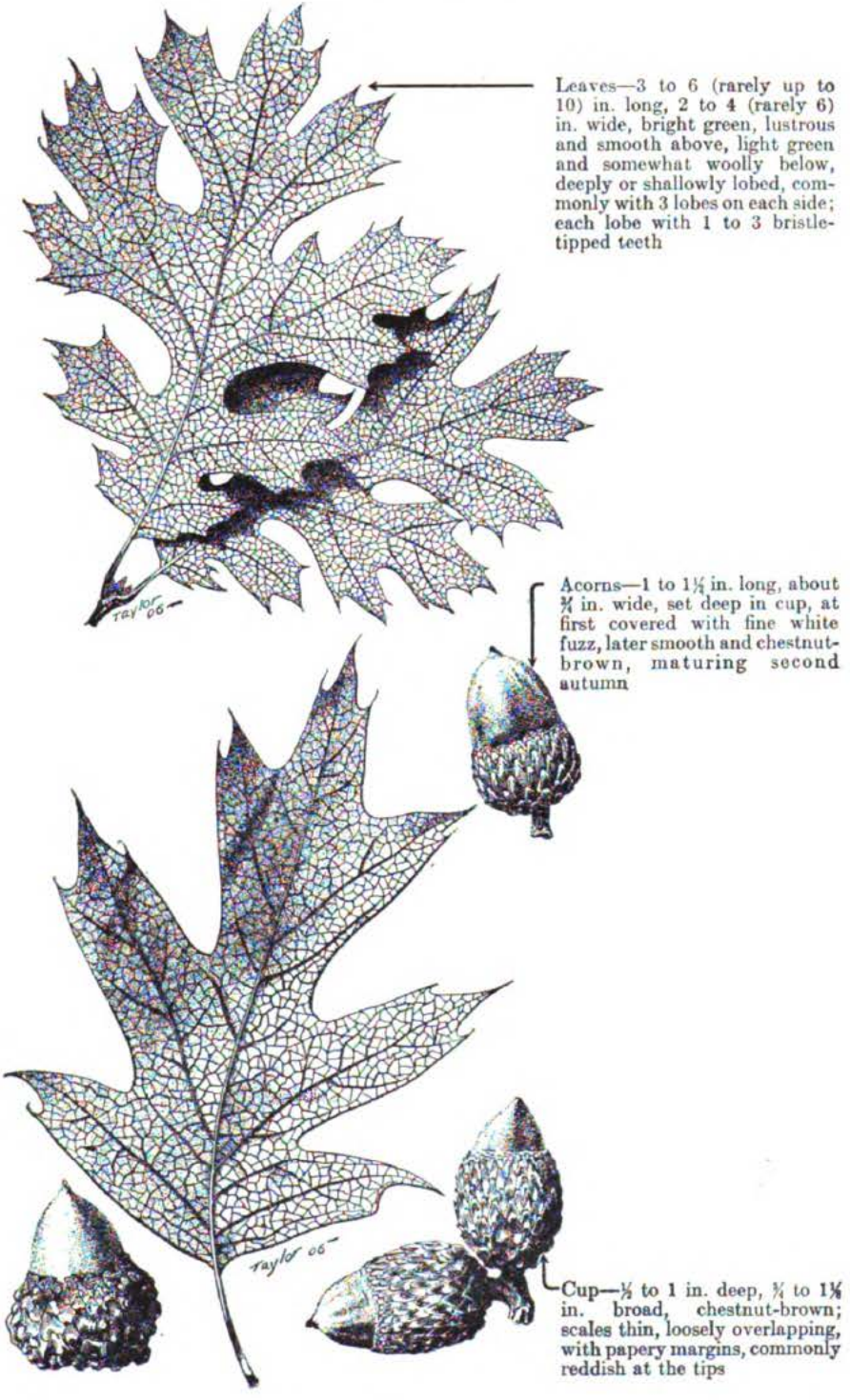
California black oak (*Quercus kellogii*). Oak acorns can be collected from the ground. They are very perishable and cannot be kept for a long time. Acorns should be planted immediately or stratified during the winter.

CALIFORNIA BLACK OAK

Quer'cus kellog'gii, syn. *Q. califor'nica*


Leaves—3 to 6 (rarely up to 10) in. long, 2 to 4 (rarely 6) in. wide, bright green, lustrous and smooth above, light green and somewhat woolly below, deeply or shallowly lobed, commonly with 3 lobes on each side; each lobe with 1 to 3 bristle-tipped teeth
Acorns—1 to 1½ in. long, about ¾ in. wide, set deep in cup, at first covered with fine white fuzz, later smooth and chestnut-brown, maturing second autumn
Cup—½ to 1 in. deep, ¾ to 1⅛ in. broad, chestnut-brown; scales thin, loosely overlapping, with papery margins, commonly reddish at the tips

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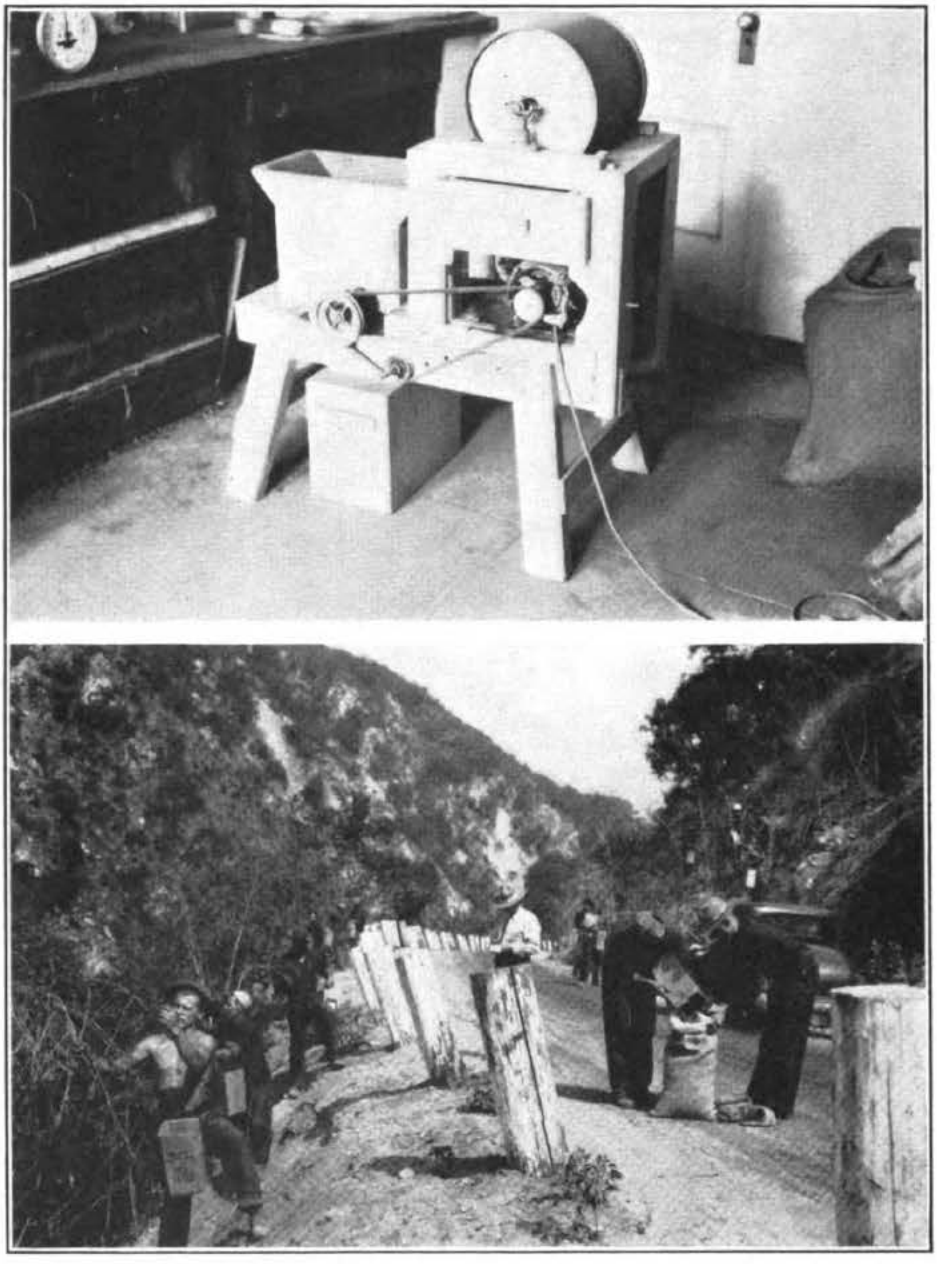
are often gathered with the seed. When insects are numerous in the seed, fumigation is needed. When that becomes necessary good results are obtained by exposing the seeds overnight in an airtight chamber to a mixture of 1 part carbon tetrachloride and 3 parts ethylene dichloride. One ounce of the mixture is sufficient for 4 cubic feet of air.



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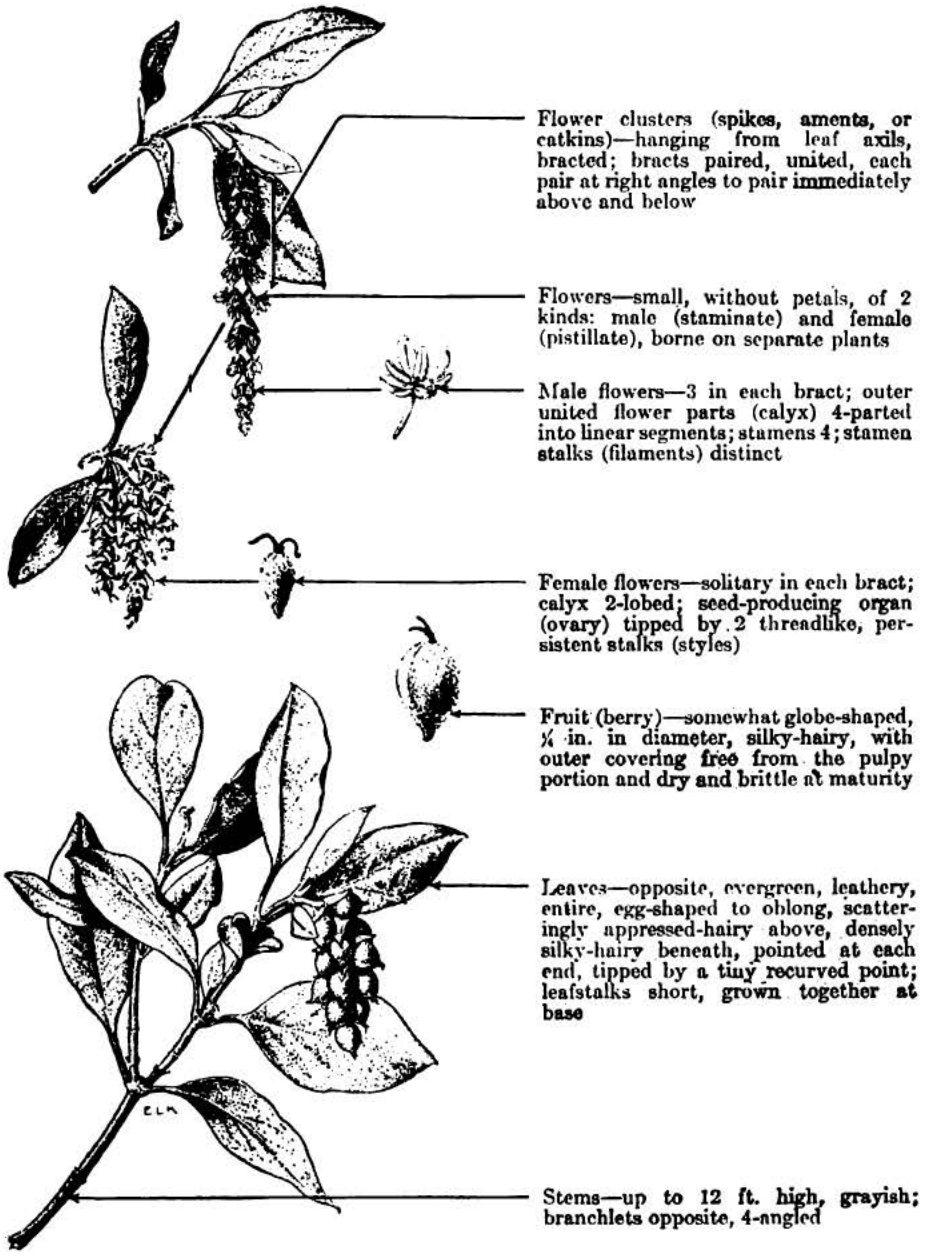
Above, power-driven fruit disintegrator combined with a seed scarifier (on top). Dry pods, burs, etc., are fed into a hopper (at the left). Released seeds and chaff fall into a box (under the apparatus). Below, C. C. C. boys collecting seed along a highway in a national forest of California. Note collecting box hung from one boy's belt.

YELLOWLEAF SILKTASSEL

Gar'rya flaves'cens


Flower clusters (spikes, aments, or catkins)—hanging from leaf axils, bracted; bracts paired, united, each pair at right angles to pair immediately above and below
Flowers—small, without petals, of 2 kinds: male (staminate) and female (pistillate), borne on separate plants
Male flowers—3 in each bract; outer united flower parts (calyx) 4-parted into linear segments; stamens 4; stamen stalks (filaments) distinct
Female flowers—solitary in each bract; calyx 2-lobed; seed-producing organ (ovary) tipped by 2 threadlike, persistent stalks (styles)
Fruit (berry)—somewhat globe-shaped, ¼ in. in diameter, silky-hairy, with outer covering free from the pulpy portion and dry and brittle at maturity
Leaves—opposite, evergreen, leathery, entire, egg-shaped to oblong, scatteringly appressed-hairy above, densely silky-hairy beneath, pointed at each end, tipped by a tiny recurved point; leafstalks short, grown together at base
Stems—up to 12 ft. high, grayish; branchlets opposite, 4-angled

Yellowleaf silktassel (*Garrya flavescens*). The juicy berries are kept in warm water to disintegrate the pulp. Seeds are then separated from the pulp and thoroughly dried.

Seeds enclosed in dry fruits, such as those of *Ceanothus*, *Pentstemon*, *Fremontodendron*, or *Castanopsis*, should first be run through a fruit disintegrator, or otherwise crushed, and the chaff then removed by means of a seed-cleaning machine or by hand screening and winnowing. In one practical type of disintegrator the dry fruits (burs, pods, or capsules) are placed in a hopper and are crushed by a revolv-

ing steel drum provided with short square pegs which pass through square openings of comblike steel plates. The distance between the drum and the plates can be regulated to permit the seeds to go through without being damaged.

Most conifer seed can be extracted by exposing the cones to direct sunlight. Cones of such species as Monterey, knobcone, or lodgepole pines that cannot be opened by the heat of the sun should be heated in a drying oven. A drying oven is an expensive apparatus, used when a large number of seed is extracted every year. When artificial heat is applied for extracting seeds from cones, the temperature should not be allowed to rise above 130° F.

It is not always necessary to clean the seed (separate the chaff from the seed), particularly in the case of large collections of such small seeds as penstemons intended for direct sowing, when exact quantities of seed need not be known.

Soft fruits, such as those of *Prunus* or *Arbutus*, should be soaked in water in a warm place to make it easier to remove the pulp. After the fruits are disintegrated, the seeds are separated from the pulp and thoroughly dried. This method of seed cleaning should be used carefully because the soft seeds of some shrubs, such as *Photinia*, are easily damaged if the berries are soaked too long.

The average number of seeds per pound of clean seed should usually be determined. This number, together with the germination percentage (discussed in the following paragraphs), is necessary in determining the value of the seed lot and the amount of seed required to produce any desired number of plants. To determine the approximate number of seed per pound, it is not necessary to count all the seeds in a pound. In the case of large seeds, such as acorns, it is enough to determine how many seeds there are in 1 ounce and to multiply the result by 16. Very small seeds should be weighed in grams. When 100 or more seeds are counted and accurately weighed, the number of seeds is divided by the number of grams weight and the result multiplied by 454 (the number of grams in a pound) in order to find the weight in pounds. Since only a small number of seeds are weighed, the results will be only approximate, but they are sufficiently accurate for the purpose.

GERMINATING

Germination tests of seeds to determine the viability (ability to sprout) should be started as soon as the seeds are gathered. One hundred seeds is the standard number used. Although the percentage of germination must be known in order to determine the seed value, it is often more important to note the extent to which the seed of each species may be refractory (resistant) to germination. This information is of greater help in learning how to germinate wild plants than the exact percentage of germination, which is not usually the same in all lots of the same species.

For judging the germinative capacity of the seed, it is not always necessary to carry on thorough studies of germination. If the plant

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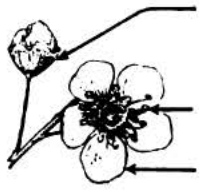
Western chokecherry (*Prunus demissa*). The fruits of chokecherries are handled in the same manner as those of silktassels.

WESTERN CHOKECHERRY

Pru'nus demis'sa

Flowers—white, up to ½ in. broad, stalked, numerous, in elongated (2 to 4 in. long), showy, dense clusters (racemes) at ends of leafy branchlets



Outer united flower parts (calyx)—5-parted, soon falling off

Stamens—numerous

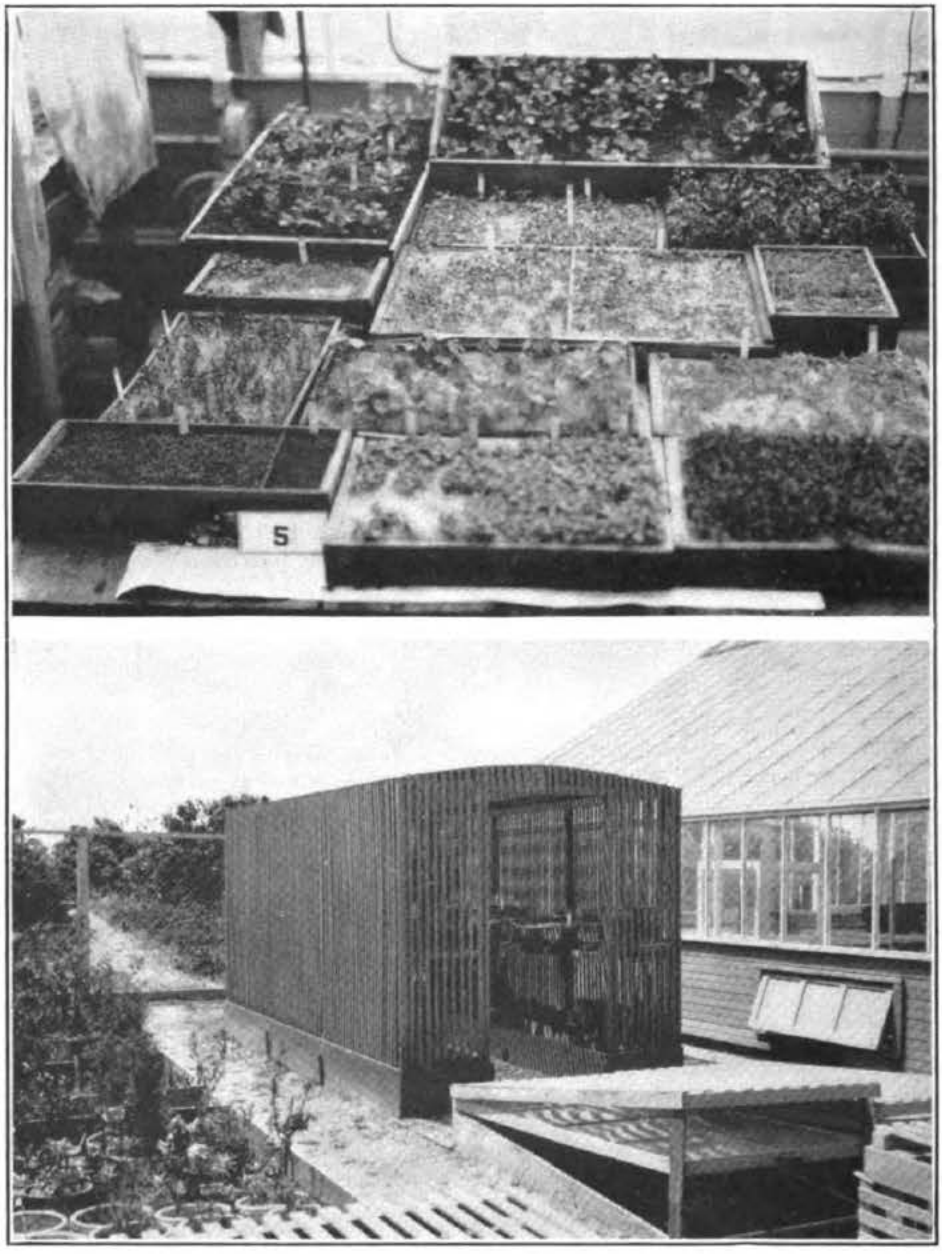
Petals—5, egg-shaped, distinct, spreading

Leaves—alternate, not evergreen, 1 to 3½ in. long, pointed at tips, finely saw-toothed around edges, dark green and hairless above, somewhat lighter and hairy beneath, on stalks about ½ in. long

Chokecherry (drupe)—globe-shaped, about ⅜ in. in diameter, on a hairless stalk, dark purple or black, juicy, sweet, or slightly puckery (astringent), 1-seeded

Twigs—slender and leafy, reddish brown

is, for instance, a member of the pea family (Leguminosae), it might be assumed that the seed would require the same handling as most seeds within this family, which is the hot-water treatment. Again, for grasses, with few exceptions, no treatment is required to hasten their germination. This general rule should be used with care. For instance, in the genus *Cercocarpus*, the seeds of *Cercocarpus betuloides* germinate rather quickly, while those of *Cercocarpus ledifolius* require chilling first.

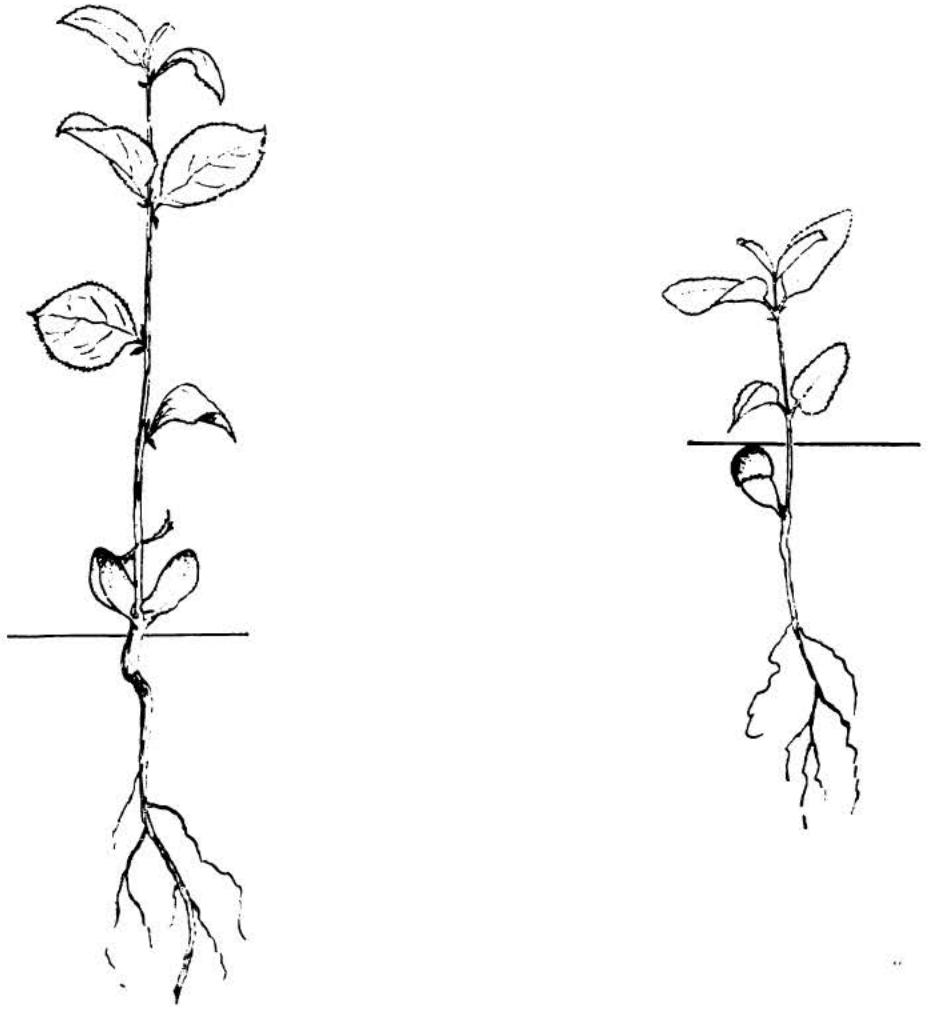


Above, seeds of wild plants are germinated in wooden flats in a greenhouse in winter or in a lath house in summer. Hundreds of plants were raised from these few flats. Below, portable lath house, 6 by 10 feet, suitable for small-scale operations. In the foreground is an electrically heated propagating frame for growing plants from cuttings.

Mountain-mahogany (*Cercocarpus betuloides*). 1, seedling is emerging from the soil. Note seed coat still attached to the tip. 2, seed leaves are opening. 3, true leaves appear. Note that they differ from the seed leaves. (Original drawing.)

Seedlings of a lupine (*Lupinus excubitus*), a bushpoppy (*Dendromecon rigida*), and a columbine (*Aquilegia truncata*) taken from germination flats. Seedlings in this stage of development are susceptible to damping-off. (Original drawing.)

Germination of the seeds can be done in a greenhouse in winter or in a small lath house in summer. The seeds are sown evenly in wooden flats and covered with light sifted soil. A common rule is that the seeds should be covered with soil as thick as the diameter of the seeds. This rule can be followed easily in the case of large seeds. Small, dustlike seeds should not be covered with soil for more than one-eighth of an inch. A convenient size for germination flats is 18 inches long, 12 inches wide, and 3 inches deep. When only a few plants are desired, flats 9 inches by 9 inches by 3 inches are more suitable.



Seedlings of western chokecherry (left) and of California buckthorn (right) ready for transplanting from germination flats. Note that in the former the seed leaves are carried above the ground, and in the latter they remain underground. (Original drawing.)

A satisfactory soil mixture for germination flats can be prepared by mixing equal amounts of good soil, sand, and leafmold. If leafmold cannot be obtained, peat may be used, but if so the mixture will have much less fertility.

Large seeds such as walnuts, acorns, hazelnuts, or chestnuts are germinated most conveniently in deep boxes filled with peat. In most cases the seedlings grown in germination tests need not be thrown away, for after the germination test is completed they can easily be transplanted into suitable pots or cans and grown to sizes suitable for special plantings.

"Damping-off" sometimes causes serious losses of young seedlings. This disease is caused by fungi which attack the seedlings at the place where they are emerging from the soil. The young plant wilts and soon dies. Excessive watering, high humidity of the air, and high temperature help to spread the disease. In many cases, merely covering the soil with half an inch of washed sand is sufficient to prevent damping-off, but very often this treatment is not satisfactory. Dusting the surface of the soil lightly with copper oxalate seems to be a very effective way to stop damping-off. For the prevention of damping-off, watering of the flats should be done in the morning, so that toward night the soil is not too wet.

Sometimes tender seedlings are attacked by aphids (lice). Spraying with nicotine sulphate will control these pests. Nicotine sulphate can be obtained in any drug or hardware store and should be used according to the directions given on the container. If the mixture is too strong it will burn the plants.

STORING

Since most wild plants do not produce abundant seed crops every year, the question of seed storage is important. The worker will not need to depend on the harvest of seed each year if he is able to collect large quantities of seed during years of plenty and to keep them in a state of viability until they are needed. Some seeds can be stored in sacks in a well-ventilated storage room under ordinary temperature conditions. Among these are seeds of the woody legumes and cereals. Some of the leguminous seeds, such as acacias, can be stored in this manner for many years. On the other hand, seeds of some conifers are fairly perishable and are better preserved if kept in airtight containers at a temperature of 36°–40° F.

For some species of plants cold storage is decidedly beneficial, while others either are not affected by the conditions of storage or are even better preserved under ordinary storage conditions. Until data become available for all species, the wisest course is to store all seed in *airtight containers* and at temperatures between 32° and 40° F.

It is very important for the preservation of germinative power that the seeds be put in cold storage in a fairly dry state. If the moisture content is too high the seeds cannot be kept for a long time. It was found by the Lake States Forest Experiment Station that when seeds are packed in airtight containers the relative humidity of the room should be not more than 30 percent. In a room kept at 70° F. this humidity is indicated by a psychrometer wet bulb depression of about 17° F. Acorns cannot be stored under these conditions, and they should be either sown immediately after the harvesting or stratified at low temperatures until the following spring. Stratification is described on page 22.

TREATING

The seeds of many plants germinate readily without the use of any special treatment. To this class belong the seeds of most grass species, those of the sunflower and evening primrose families, and many others. However, some species require a long time to germinate, and these can be divided into two groups. The first group includes seeds that have a hard seed coat. In the second group are seeds whose inability to germinate comes from the internal qualities of the seed.

Mechanical treatment.—Seeds in the first group can be prepared for planting by some means that will make the seed coat permeable (so that water and air can pass through). This can be done in various ways, including scarification (scratching), hot-water treatment, and a sulphuric-acid bath.

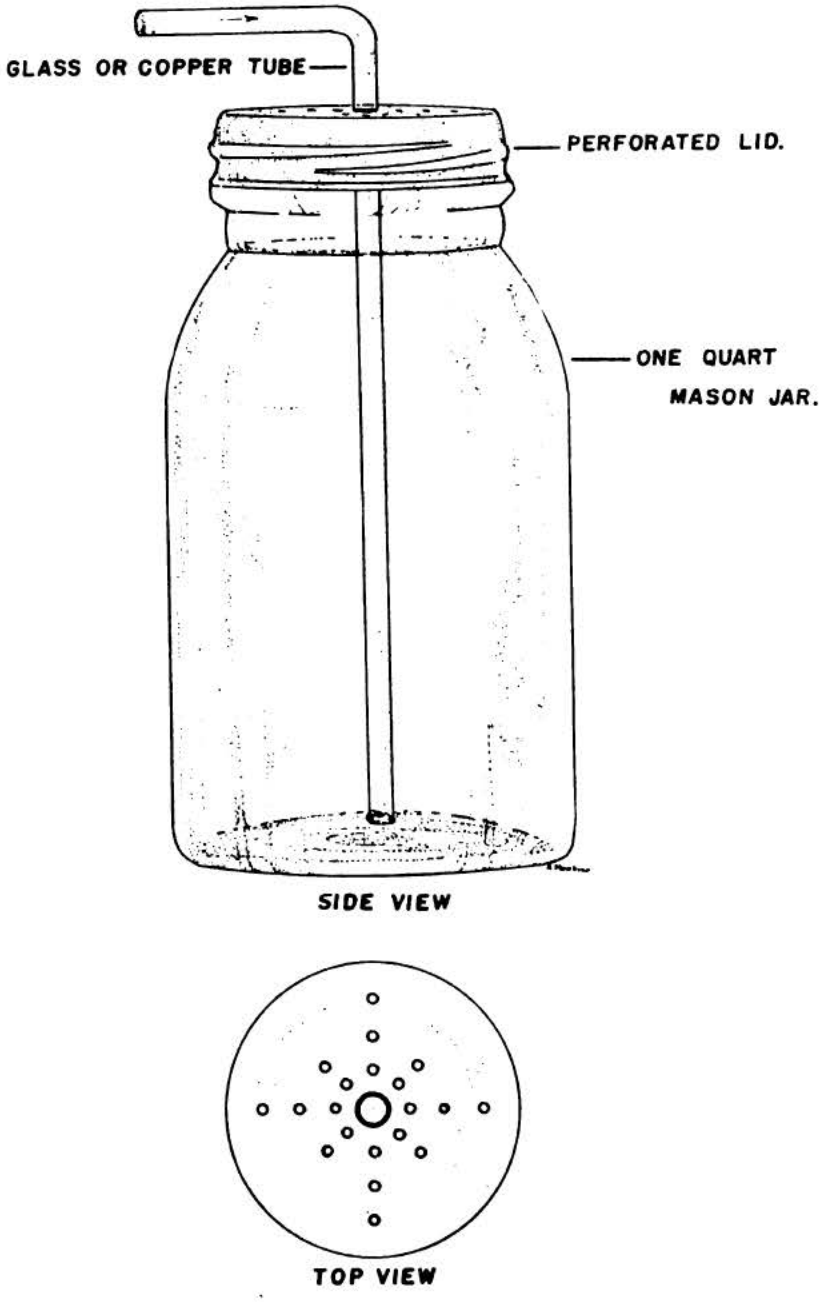
Scarification has been widely used, for example, with small leguminous seeds such as sweetclover. Among California native plants the cloverlike *Lotus* is one of the very few whose seeds require scarification. When only a small amount of seed is to be scarified, the seeds may be rubbed gently between two sheets of sandpaper. Unfortunately, by this method it is difficult to insure uniform scarification. When large quantities of seed are to be scarified, it is well to use a revolving drum filled with sand and driven either by hand or power. A convenient scarifier of this type is described in The Seed Scarifier. (See appendix 2.) Another type of seed scarifier is used at the California Forest and Range Experiment Station. It is attached to the fruit disintegrator described on page 12 and is driven by the same electric motor. Seeds are mixed with coarse sand and placed in the drum. Two hours of treatment suffice to make *Lotus* seeds germinable.

The hot-water treatment consists in simply soaking the seeds in water hot enough to loosen their seed coats. The usual method is to place the seeds in a vessel, add three or four times as much hot water (170°–180° F.) as seeds, and allow the seeds to stand in the gradually cooling water overnight. By the next morning the seeds will have become swollen with water, and in this condition they should be promptly planted. This treatment will suffice for most hard-coated seeds and the hot water will do them no injury. Some seeds, like *Ceanothus sorediatus*, can even be boiled in water for a short time without injury.

Acid treatment.—Some seeds, as for example those of *Rhus integrifolia*, have seed coats so tough that more treatment is necessary. Such seed coats can be made germinable by treatment with concentrated sulphuric acid (specific gravity 1.84). The technical (cheap) grade of sulphuric acid can be obtained in a drug or hardware store. Thoroughly dried seeds are put into a heat-resistant jar and covered with the acid, the volume of acid being at least twice the volume occupied by the seeds. The contents should be stirred occasionally until the treatment is completed. (The length of treatment required for different species is indicated in appendix 1.) When treatment is complete the acid should be carefully poured off and saved for future use. The jar should then be covered with a perforated lid and a large stream of water poured into the jar through the hole in the

lid by means of a rubber tube. It should be mentioned that when a small quantity of water is poured into acid, a violent boiling takes place. Therefore, large amounts of cold water should be used, and,

A SIMPLE APPARATUS FOR TREATING SEEDS WITH SULPHURIC ACID.



as a further safety measure, the jar should be wrapped in a heavy cloth, and the operator should protect his eyes with goggles. After the seeds are given this first rinsing, the jar should be opened and

washing soda added at the rate of 1 tablespoon of soda for every quart of the contents to neutralize the acid. The jar is then left until the bubbling ceases. While still in the same jar, the seeds should be washed for 2 hours with running water. They are then ready for planting.

Physiological treatment.—Certain kinds of seeds do not germinate until changes have occurred inside the seed. This "after-ripening" or conditioning of the seed requires definite combinations of moisture-temperature-time relations which may differ for different species. In the warmer parts of the Western States the required combination may not occur in nature every year. Seeds falling annually may lie dormant for several years only to germinate in great numbers in a season when conditions are just right.

For seeds of this type, *stratification* in a cold room or an ice box has been found to be the best method of inducing germination. It consists of placing the seeds in flats of sand or light soil, and keeping the flats at a temperature of 36°–40° F. for various lengths of time. For many species the flats must be held at this temperature for 3 months, with occasional waterings. Average required periods for other species are indicated in appendix 1.

When large amounts of seeds are stratified, they are mixed with twice their volume of sand and screened peat (half and half), placed in suitable containers such as 5-gallon cans or wooden kegs, covered with heavy paper, and put in cold storage at a temperature between 34° and 40° F. The sand-peat mixture should be moist, but not dripping wet. A few holes should be made at the bottom of the container in order to provide for drainage and aeration. The stratified seed should be inspected occasionally and slightly sprinkled with water if necessary.

Cold storage of seeds and stratification should not be confused. For storage purposes *dry seeds* are put in airtight containers, but for stratification the seeds are put in a *moist medium* (soil) and in well-ventilated containers.

In nursery practice somewhat similar results are achieved with some species by sowing in outdoor seedbeds in the fall. With seed sown outdoors whether in nursery or field, it is not the severe winter cold that renders the seed germinable, but rather the temperatures of the spring months fluctuating around the freezing point.

Treating conifer seeds.—Seeds of some conifers, such as those of Jeffrey or Monterey pines, germinate well without any treatment. Others, like ponderosa pine seeds, germinate fairly well when sown untreated but germinate very much better if they have been stratified. Again, there are many conifers whose seeds require stratification. When sown without treatment they behave erratically and often fail to germinate. To this group belong seeds of sugar and Digger pines, incense cedar, and some other species. In forest nurseries fall sowing of conifer seed gives better results than spring sowing. When the seed has to be sown in the spring, it is advisable to stratify them, as explained above, for 2 or 3 months before sowing. If this practice is not followed, germination may be delayed for a year or it may never occur.

PROPAGATING WILD PLANTS

PROPAGATING BULBOUS PLANTS BY SEED

Propagation of wild lilies, mariposas (*Calochortus*), and other plants of the lily family should not be attempted from seed unless the project is of long duration. Plants of this group grow very slowly during the first years of their lives. For instance, mariposas will bloom 3 years from the time the seeds are sown. Stratification of the seeds is necessary in most species of the lily family. After the first blooming in the pots, the bulbs can be planted in a permanent place.

PROPAGATING WILD PLANTS BY VEGETATIVE MEANS

Plants can be multiplied not only from seeds but also by vegetative means, that is, by cuttings, division, and grafting. Grafting is a purely horticultural method of plant propagation and is rarely used with wild plants. Persons who would like to try this method are referred to The Modern Nursery, by Laurie and Chadwick. (See appendix 3.)

Multiplication of plants by division is perhaps the easiest method of all. A large clump of roots is divided into many small clumps, and each one gives rise to a new plant. This method can be used with delphiniums and other perennial plants that have a mass of fibrous roots.

Propagation by cuttings is the most common method with shrubs and trees, although some perennial herbs can also be propagated by this means. When a piece of stem or branch is placed in moist soil, it produces roots, and a new plant is thus formed. In spring and early summer young succulent parts of a plant provide material for so-called green or softwood cuttings. When the season advances the branches become somewhat woody, and the cuttings taken from them are called mature or hardwood cuttings. Propagation of plants by cuttings is described in detail in The Vegetative Propagation of Plants, by Gardner. (See appendix 3.)

Theoretically speaking, all plants can be propagated by cuttings. Some of them, as for example willows, are propagated very easily by cuttings, and others, such as oaks or pines, are extremely difficult to propagate by this method. Willow cuttings root so easily that when a piece of stem is driven into slightly moist ground it soon produces roots on the lower half and leaves on the upper. Complete instructions for handling willow cuttings are given in Erosion Control on Mountain Roads, by Kraebel. (See appendix 3.) Numerous species of *Arctostaphylos* (manzanita) are difficult to propagate by seeds. It takes a long time and often the percent of germination is low. It is far more convenient to propagate manzanitas by cuttings, although the method of forcing development of roots in this case is not as simple as with willows.

Most wild plants need propagating frames for their rooting. The simplest kind of propagating frame consists of a wooden box with a few holes in the bottom. The box is half filled with clean sand and covered with glass. The cuttings, 2 or 3 inches long, are planted in the sand, sprinkled frequently with water and transplanted into pots

as soon as good roots are developed. The propagating frame should get plenty of light, but it should not be exposed to the sun. More elaborate types of propagating frames, in which sand is kept warm by electricity, are described in such modern nursery manuals as Electric Heat for Propagating and Growing Plants, by Moses and Tavernetti. (See appendix 3.)

Recently many chemical preparations have been introduced that promote rapid development of roots in cuttings. These are known as root-producing hormones. They can be obtained from any reputable nursery store or even from mail-order houses. When used according to instructions these hormones in many cases (but not all) produce roots in cuttings which otherwise are difficult to root. A suitable root hormone can be prepared by dissolving indole-butyric acid in 50 percent alcohol, so that each cubic centimeter of alcohol contains 4 milligrams of the acid. Two to six cubic centimeters of this solution in 1 quart of water can be used for rooting. The ends of the cuttings are placed in the solution for 24 hours, rinsed with water, and then planted in the propagating frame.

Below is a list of some wild plants that have been propagated by cuttings at the California Forest and Range Experiment Station. Some of the plants listed are easier to propagate by seeds but for some others, such as *Arctostaphylos*, *Symphoricarpos*, *Platanus*, or *Baccharis*, propagation by cuttings is easier. This list is far from complete. It is intended merely to show that if necessary—for instance, when no seeds are available—many wild plants can be propagated vegetatively.

Some wild plants that can be propagated vegetatively

Botanical name	Common name	Type of vegetative propagation
Antirrhinum	Snapdragons	Stem cuttings; easily rooted.
Arctostaphylos	Manzanitas	Tips of branches 2 to 3 inches long; propagated in a frame with bottom heat.
Aster	Asters	Stem cuttings or division of clumps.
Baccharis viminea	Mule fat	Woody pieces of stems root easily in the open.
Calycanthus occidentalis	California sweetbrush.	Tips of branches 2 to 3 inches long; propagated in a frame.
Carpenteria californica	Carpenteria	Tips of branches 2 to 3 inches long; propagated in a frame with bottom heat. Root-producing hormone used.
Ceanothus arboreus	Tree ceanothus	Do.
Ceanothus papillosus	Wartleaf ceanothus	Do.
Ceanothus prostratus	Squawcarpet	Do.
Ceanothus thyrsiflorus	Blue-myrtle	Do.
Ceanothus velutinus	Snowbrush	Do.
Chamaecyparis lawsoniana.	Port Orford cedar	Tips of branches 2 to 3 inches long; propagated in a frame. Easily rooted.
Cornus glabrata	Dogwood	Tips of branches 2 to 3 inches long; propagated in a frame.
Crataegus douglasii	Black hawthorn	Tips of branches 2 inches long; propagated in a frame with bottom heat.

Some wild plants that can be propagated vegetatively—Continued

Botanical name	Common name	Type of vegetative propagation
Cupressus macnabiana	Macnab cypress	Root-producing hormone used.
Gilia aggregata	Scarlet gilia	Stem cuttings; propagated in a frame.
Hypericum formosum	St. Johns wort	Stem cuttings; rooted easily in the open.
Ledum glandulosum	Labrador-tea	Tips of branches 2 inches long; propagated in a frame with bottom heat.
Lepargyrea (Shepherdia) argentea.	Silver buffaloberry	Tips of branches 2 inches long; propagated in a frame with bottom heat.
Lithocarpus densiflora	Tanoak	Tips of branches 3 inches long; propagated in a frame with bottom heat. Takes a long time to root.
Lupinus	Lupines	Stem cuttings; propagated in a frame with bottom heat.
Mesembryanthemum	Sea fig	Cuttings cured in sun for 2 days before being planted. Can be planted in the open.
Mimulus	Monkeyflower	Stem cuttings; propagated in a frame with bottom heat.
Myrica californica	Pacific waxmyrtle	Tips of branches 3 inches long; propagated in a frame with bottom heat.
Osmaronia cerasiformis	Osmaronia	Do.
Pentstemon	Pentstemons	Stem cuttings; propagated in a frame with bottom heat.
Photinia salicifolia	Christmasberry; toyon.	Tips of branches 3 inches long; propagated in a frame with bottom heat.
Pinus ponderosa	Ponderosa pine	Tips of branches 5 inches long; propagated in a frame with bottom heat. Very difficult to root.
Pinus radiata	Monterey pine	Tips of branches 4 inches long; propagated in a frame with bottom heat. More easily rooted than *P. ponderosa*.
Platanus racemosa	California sycamore	Stem cuttings ½ inch in diameter. Easily rooted in the open.
Rhamnus californica	California buckthorn	Root-producing hormone used. Bottom heat.
Rhamnus crocea	Hollyleaf buckthorn (redberry).	Tips of branches 2 inches long; propagated in a frame with bottom heat.
Salix	Willows	Easily rooted in the open. Consult U. S. Department of Agriculture Circular 380.
Salvia spathacea	Sage	Tips of branches 2 inches long; easily rooted in a frame.
Staphylea bolanderi	Sierra bladdernut	Do.
Symphoricarpos	Snowberry	Stems easily rooted in the open.
Vaccinium occidentale	Western blueberry	Tips of branches 2 inches long; propagated in a frame. Easily rooted.
Vaccinium ovatum	Box blueberry	Do.

ESTABLISHING A WILD-PLANT NURSERY

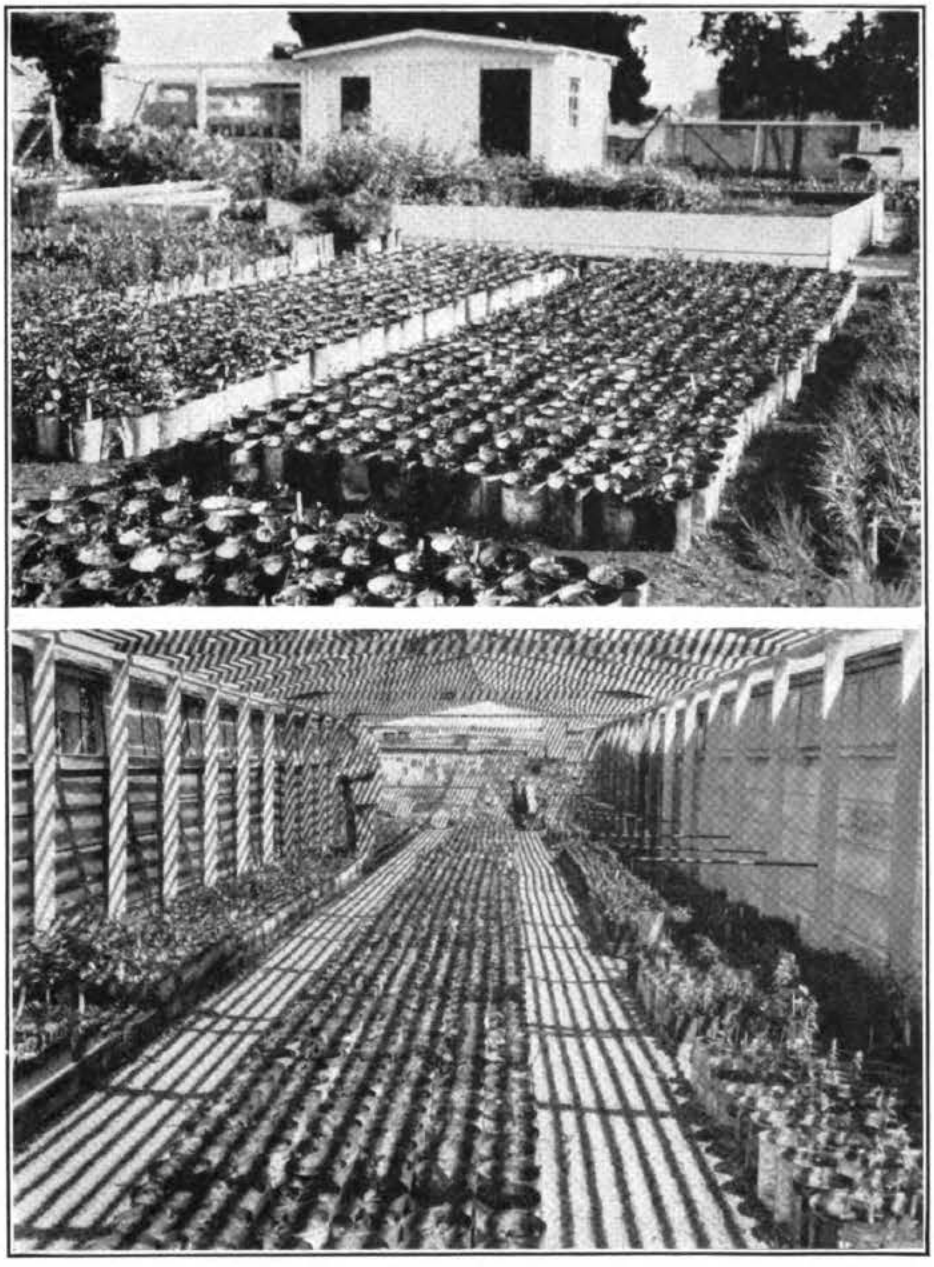
The growing of wild shrubs and herbaceous plants differs considerably from the growing of forest trees. When forest-tree seedlings are needed, they are grown in very large quantities. The seeds are sown in the open and the seedlings either are kept for some time in transplanting beds before planting or are planted directly from the seedbeds to the permanent location. In either case bare-root stock is used.

Wild shrubs and flower seedlings, on the other hand, are extremely difficult to plant as bare-root stock, especially under the semiarid conditions in some Western States. Direct sowing of seeds can be practiced mainly with annual plants. In planting perennial plants, especially shrubs, potted stock is preferable The use of potted plants is more expensive than the planting of bare-root stock, but success is more certain. Moreover, in many projects, such as planting around forest-ranger stations or public campgrounds, relatively small numbers of large plants are needed and thus more elaborate methods of growing the stock can be practiced.

As already described, the seeds are started in flats in a greenhouse in winter or in a lath house in summer. When the seedlings are big and strong enough to withstand moving from the flats they can be transplanted. Convenient containers for transplanting are tar-paper boxes 6 or 8 inches long and 2 by 2 inches by 6 or 8 inches wide. The boxes have no bottom. They are put in flats side by side and filled with soil, which should be somewhat heavier than the soil in germination flats. Fifty paper pots may be placed in each flat. In gardening similar pots are used for transplanting watermelons. Such tar-paper pots can be purchased at a price of about $10 per thousand, or they can be made at the nursery from a heavy grade of tar paper and glued with asphaltum paint at a slightly lower cost. Paper pots can support the plants for 2 years. Eventually they become brittle and rot. In planting at the permanent site the pot is planted with the plant.

Convenient containers for larger plants are 1-gallon tin cans. These will support transplant growth for 3 or 4 years. The bottom of the can should be punctured in several places in order to provide drainage. The transplanted stock should be kept in a lath house and when it is established the containers can be placed in rows outdoors. In transplanting the stock in 1-gallon cans to a permanent location, the opposite sides of the cans are cut from top to bottom with tin snips, the can is removed, and the plant is planted with the soil intact. The soil in the cans should not be too light, or it will crumble and expose the roots. When a plant is "pot-bound" its roots are twisted in circles at the bottom of the can. It is advisable to straighten the roots as much as possible and thus facilitate development of a strong tap root.

Operation of a wild-plant nursery is not very expensive. A greenhouse is desirable but not absolutely necessary. A lath house and a tool shed are the only permanent structures needed for running the nursery. The lath house can be constructed in panels, in order to move it easily from one location to another. The tin cans should be



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Wild-plant nursery, Berkeley, Calif.

Above, seedlings are transplanted into 1-gallon cans and placed in rows, ready for shipment. Below, lath house filled with transplants of various species of shrubs. Note paper pots in flats at the left. Plants in the center are grown in 1-gallon cans.

collected far ahead of the nursery operation, in order to assure an ample supply.

Wild plants in the nursery should not be watered excessively. They will stand more drought than ordinary garden plants. A close watch

should be kept for pests and diseases. Bordeaux mixture and nicotine sulphate solution will control most of them. In the case of serious infestations a specialist, such as a farm adviser, should be consulted. If assistance to combat disease or pests is sought by mail, it is important to send a sample of damaged plants, in the case of fungi, or a few insects.

APPENDIX 1.[1]—SEED AND CULTURAL DATA FOR SOME WESTERN PLANTS

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Acer macrophyllum, bigleaf maple (California, Oregon, Washington).	September–October	3,200	68	90	2 months' stratification.
Adenostoma fasciculatum, chamise (California).	May–September	413,000	11	75	10 percent sulphuric acid for 15 minutes.
Adenostoma sparsifolium, redshanks (California).	May–June	400,000	33	40	Do.
Aesculus californica, California buckeye (California).	November	10	7	75	Germinated in leafmold or moss.
Agoseris heterophylla (California, Oregon, Washington).	May	722,000	60	17	No treatment needed.
Agoseris retrorsa (California)	do	224,000	36	20	Do.
Agropyron cristatum, crested wheatgrass (California, Oregon, Washington; east to Colorado).	[3]	280,000	5	70	No treatment needed. Naturalized from Asia.
Agropyron laeve (California)	June–July	72,000	6	89	No treatment needed.
Agropyron pauciflorum, slender wheatgrass (California, Oregon, Washington).	July	210,000	10	16	Do.
Agropyron saxicola (California, Idaho, Oregon, Washington).	August–September	454,000	7	55	Do.
Alnus rhombifolia, white alder (California, Oregon, Washington).	May–October	687,000	10	56	Do.
Alnus rubra, red alder (California, Oregon, Washington).	May–July	1,087,000	13	14	Do.
Alnus tenuifolia, mountain alder (California, Oregon, Washington; east to Rocky Mountains).	August–September	675,000	9	16	Do.
Alnus viridis var. *sinuata*, thinleaf alder (California, Oregon, Washington).	do	2,021,000	14	12	Do.
Amorpha californica, California indigobush (California).	July–September	38,000	5	42	No treatment needed for fresh seeds. Hot water for stored seeds.
Aplopappus bloomeri, Bloomer goldenbush (California, Nevada, Oregon, Washington).	September–October	233,000	21	50	No treatment needed.

[1] The information presented in this appendix is based on experiments performed by the senior author at the California Forest and Range Experiment Station, Berkeley, Calif.

[2] For California conditions only.

[3] See U. S. Department of Agriculture Leaflet 104.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Aplopappus ericoides, heatherleaf goldenbush (California).	October–November	718,000	5	80	No treatment needed.
Aplopappus parishii, Parish goldenbush (California).	do	1,633,000	4	95	Do.
Aplopappus pinifolius, pineleaf goldenbush (California).	do	1,000,000	4	48	Do.
Aplopappus squarrosus, coast goldenbush (California).	August–October	173,000	3	80	Do.
Arbutus menziesii, Pacific madrone (California, Oregon, Washington).	October–December	[4] 2,000	103	55	3 months' stratification.
Arctostaphylos patula, greenleaf manzanita (California, Oregon, western Nevada).	August–October	[4] 1,700			3 months' stratification. More easily propagated by cuttings.
Asclepias mexicana, narrowleaf milkweed (Arizona, California, Nevada, Oregon).	do	72,000	8	96	No treatment needed.
Aster canescens (Arizona, California, Oregon, Washington).	June	821,000	6	14	Do.
Astragalus antisellii, locoweed (California).	do	183,000	37	23	Do.
Atriplex johnstonii, Johnston saltbush (California).	May–July	63,000	14	22	Do.
Atriplex semibaccata, Australian saltbush (California).	July–October	75,000	4	64	No treatment needed. Native of Australia.
Azalea occidentalis, western azalea (California).	July–September	4,000,000	11	75	Germinate seed in fine peat soil.
Baccharis pilularis, kidneywort (California, Oregon).	September–November.	8,200,000	7	92	No treatment needed.
Baccharis viminea, mule fat, (California).	May	5,000,000	10	75	Easily propagated by stem cuttings in the same manner as willow. Very valuable for erosion control and for low windbreaks.
Bebbia juncea (Arizona, California).	June	748,000	10	30	No treatment needed.
Beloperone californica (California).	do	47,000	5	96	Do.
Berberis nevinii (California)	do	57,000	95	77	3 months' stratification.
Betula fontinalis, water birch (California, Oregon, Washington).	July–August	4,000,000	33	16	No treatment needed.
Brassica nigra, black mustard (warmer parts of California).	June	292,000	3	91	No treatment needed. European weed.
Brickellia (Coleosanthus) californica (Arizona, California, Colorado, Nevada, New Mexico).	August–October	599,000	3	36	No treatment needed.
Brickellia (Coleosanthus) incana (California, southern Nevada).	May–June	171,000	33	52	Do.

[2] For California conditions only.

[4] Dry fruits.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Bromus carinatus (California, Oregon, Washington).	June	61,000	8	85	No treatment needed.
Bromus laeripes (California, Oregon, Washington).	June–July	111,000	16	78	Do.
Calycanthus occidentalis, California sweetshrub (California).	September–October	8,000	14	82	Do.
Carpenteria californica, carpenteria (California).	do	15,020,000	17	80	Careful watering.
Castanopsis chrysophylla, golden chinquapin (California, Oregon).	September	700	24	50	No treatment needed. Germinate in peat.
Castanopsis sempervirens, Sierra chinquapin (California).	September–October	1,200	16	30	Do.
Ceanothus arboreus, tree ceanothus (California).	May–June	50,000	10	87	Hot water.
Ceanothus cordulatus, whitethorn (California, southern Oregon).	July–September	141,000	96	65	Hot water and 3½ months' stratification.
Ceanothus crassifolius, hoaryleaf ceanothus (California).	May–June	65,000	44	45	Hot water.
Ceanothus cuneatus, wedgeleaf ceanothus (California, southern Oregon).	April–June	56,000	11	81	Do.
Ceanothus cyaneus (California).	June–August	79,000	94	35	Hot water and 3 months' stratification.
Ceanothus dentatus, cropleaf ceanothus (California).	June–July	95,000	92	88	Do.
Ceanothus divaricatus, whitebark ceanothus (California).	July–August	73,000	98	45	Do.
Ceanothus diversifolius, trailing ceanothus (California).	June–July	84,000	94	61	Do.
Ceanothus foliosus, wavyleaf ceanothus (California).	May–July	183,000	12	50	Hot water only, or hot water and 3 months' stratification.
Ceanothus incanus, coast whitethorn (California).	do	92,000	94	88	Hot water and 3 months' stratification.
Ceanothus integerrimus, deerbrush (California).	June–July	58,000	94	71	Do. Very important forage plant for deer.
Ceanothus jepsonii, musk bush (California).	do	43,000	34	35	Hot water. Prefers alkaline soil.
Ceanothus macrocarpus, bigpod ceanothus (California).	May–June	15,000	7	90	Hot water. Ornamental.
Ceanothus oliganthus, hairy ceanothus (California).	do	73,000	16	62	Hot water.
Ceanothus papillosus, wartleaf ceanothus (California).	do	102,000	98	74	Hot water and 3 months' stratification.
Ceanothus parryi, ladybloom (California).	July	155,000	100	75	Do.
Ceanothus parvifolius, littleleaf ceanothus, sweet birch (California).	do	78,000	96	40	Do.

[2] For California conditions only.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Ceanothus prostratus, squawcarpet (California, Oregon, Washington).	July	42,000	92	71	Hot water and 3 months' stratification. Keep seedlings in a dry hothouse for the first year.
Ceanothus rigidus (California)	May–June	72,000	13	77	Hot water. Rapid growing.
Ceanothus sorediatus, jim brush (California).	May–July	122,000	93	100	Boil in water for 5 minutes, then stratify for 3 months.
Ceanothus spinosus, spiny ceanothus ("myrtle") (California).	May–June	60,000	98	96	Hot water and 3 months' stratification.
Ceanothus thyrsiflorus, blue blossom ("myrtle") (California, southern Oregon).	April–July	48,000	5	46	Hot water.
Ceanothus velutinus, snowbrush (California, Oregon, northern Rocky Mountains, Washington).	July–August	71,000	100	68	Hot water and 3 months' stratification.
Ceanothus verrucosus, wartystem ceanothus (California).	April–June	72,000	9	72	3 months' stratification or hot water.
Cercis occidentalis, California redbud (California, east to Texas).	September–February	12,000	100	60	Hot water and 3 months' stratification.
Cercocarpus betuloides, birchleaf mountain-mahogany (California, Oregon, east to Rocky Mountains).	June–July	30,000	11	89	No treatment needed. Sow outdoors in fall.
Cercocarpus ledifolius, curlleaf mountain-mahogany (California, east to Colorado, Oregon, Washington).	May–June	42,000	163	44	No treatment needed. Sow out doors.
Chaenactis artemisiaefolia (California).	June	980,000	95	32	No treatmend needed.
Chaenactis glabriuscula (California).	May–June	1,206,000	16	56	Do.
Chenopodium ambrosioides, Mexican tea (California).	September–November.	5,480,000	17	34	Do.
Chrysopsis villosa (California, Oregon, Washington, east to Minnesota and Texas).	July–September	403,000	5	14	No treatment needed. Naturalized from tropical America.
Chrysothamnus nauseosus, rubber rabbitbrush (Great Basin region).	October–November	335,000	3	36	No treatment needed.
Clarkia elegans (California)	May–June	2,225,000	14	30	Do.
Clematis lasiantha, pipestem (California).	June–September	184,000	37	58	Do.
Clematis ligusticifolia, Yerba de Chivato (California, Oregon).	do.	93,000	27	21	Do.
Clematis pauciflora, ropevine (California).	May–July	85,000	28	36	Do.
Coreopsis bigelovii (California).	May	310,400	34	5	Do.

[2] For California conditions only.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Coreopsis douglasii (California, east to Arizona).	June	704,500	3	39	No treatment needed.
Cornus nuttallii, Pacific dogwood (California, Oregon, Washington).	September–October	3,000	71	100	Fresh seeds germinate well; stored seeds treated with sulfuric acid for 4 hours and stratified for 3 months.
Corylus californica, California hazel (California, Oregon, Washington).	do	400	96	20	3 months' stratification in peat.
Crossosoma californicum (California).	May–July	(3)	14	24	No treatment needed. Rare species.
Crotalaria intermedia, cultivated in California.	Seed must be purchased from dealers.	87,000	4	54	No treatment for fresh seed. Old seed stratified for 3 months. Introduced plant.
Cryptantha intermedia (California).	August	995,000	8	63	No treatment needed.
Cucurbita foetidissima (California).	June	23,000	8	4	Do.
Cytisus scoparius, Scotch broom (escaped from gardens and now grows wild in California, Oregon, and Washington).	July–September	68,000	6	44	Scarification or hot water. Native of Europe.
Dendromecon rigida, bush-poppy (California).	May–July	50,000	102	21	Alternate stratification daily in room of 40° F. and of 70° F. for 3 months.
Dicentra (*Bikukulla*) *chrysantha*, golden eardrops (California).	do	400,000			No results from attempts to germinate this species.
Digitalis purpurea, foxglove (occasionally found in wild state in California).	August	4,000,000	8	66	No treatment needed. Naturalized from Europe.
Diplacus aurantiacus, bush monkeyflower (California).	July–September	16,000,000	8	56	No treatment needed.
Diplacus longiflorus (California).	May–July	9,343,000	10	46	Do.
Diplacus parviflorus (California).	June–August	9,500,000	19	82	Do.
Diplacus puniceus, redbush monkeyflower (California).	May–June	13,000,000	14	35	Do.
Elymus condensatus, giant wild-rye (California, Oregon, Washington, east to Nebraska).	May–July	25,000	12	22	No treatment needed. Use seeds from northern regions. Seeds from southern California are usually sterile.
Elymus glaucus (California, Oregon, Washington, east to Michigan).	June–August	100,000	6	85	No treatment needed.

[2] For California conditions only.

[3] Not known.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Elymus triticoides (Arizona, California, Colorado, Nevada, Oregon, Washington).	June–September	243,000	20	10	No treatment needed.
Emmenanthe penduliflora, whisperingbells (California).	June–July	1,400,000	10	14	Do.
Encelia actoni, Acton encelia (California, east to Utah).	May–June	348,000	4	32	Do.
Encelia californica, California encelia (California).	do	327,000	7	28	Do.
Encelia farinosa, white brittlebush (western Arizona, California).	May–July	570,000	7	20	Do.
Epilobium californicum (California).	May–August	1,633,000	4	95	Do.
Eriogonum fasciculatum, wild-buckwheat (California).	June–August	493,000	6	46	Do.
Eriogonum giganteum (California).	June–July	899,000	4	47	Do.
Eriogonum latifolium (California).	July–September	504,000	7	24	Do.
Eriophyllum confertiflorum, goldenyarrow (California).	May–September	2,600,000	11	21	Do.
Erysimum (Cheirinie) asperum, western wallflower (California).	June–August	373,000	7	84	Do.
Eschscholtzia californica, California poppy (California).	April–July	540,000	6	49	Do.
Fallugia paradoxa, Apache plume (California, Colorado, Nevada).	June–July	420,000	7	42	Do.
Festuca megalura, foxtail fescue (California, Idaho, Oregon, Washington).	June	857,000	25	15	Do.
Festuca octoflora (Arizona, California).	May–June	1,724,000	63	24	Do.
Fraxinus dipetala, California shrub ash (California).	July–September	8,000	199	56	3 months' stratification.
Fraxinus oregona, Oregon ash (California, Oregon, Washington).	August–September	10,000	99	54	Do.
Fraxinus velutina, Arizona ash (California, east to Texas).	May–June	20,000	26	60	Do.
Fremontodendron californicum, flannelbush (California).	August–September	15,000	6	50	Hot water; stratification beneficial.
Fremontodendron californicum var. *mexicanum* (California).	July–August	27,000	66	55	Do.
Garrya buxifolia (California, Oregon).	September–October	29,000	135	5	3 months' stratification.
Garrya elliptica, silk tassel bush (California).	October–December	18,000	135	53	Do.
Garrya fremontii, bearbrush (California).	do	26,000	107	24	Do.

[2] For California conditions only.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Gaultheria shallon, salal (California, Oregon, Washington).	August–September	5,000,000	27	73	Stratification beneficial but not necessary.
Geranium incisum (California, Oregon, Washington.)	....do.....	.....	18	80	No treatment needed.
Godetia amoena, lilya (California, Oregon, Washington).	July–September.....	3,400,000	8	80	Do.
Grindelia camporum, field gumplant (California).	August–October.....	132,000	3	44	Do.
Hedysarum coronarium. French honeysuckle (cultivated in California).	August.....	70,000	2	52	Hot water. Introduced from Europe.
Helianthemum scoparium, broom sunrose, rush-rose (California).	June–September...	1,000,000	5	64	No treatment needed.
Helianthus annuus, common sunflower (introduced to the Western States from Great Plains region).	July–September.....	32,000	4	86	Do.
Helianthus gracilentus, slimstem sunflower (California).	... do	259,000	22	43	Do.
Hemizonia wrightii (California)	September–October.	780,000	4	26	Do.
Heracleum lanatum, cow-parsnip (California, north to Alaska, east to Atlantic).	July–September	76,000	32	39	Do.
Hypericum formosum (California).	....do.....	1,916,000	22	50	Do.
Isomeris arborea, burrofat (California).	May–July	5,000	6	70	Do.
Juglans californica, California walnut (California).	July–August.....	75	26	35	Germination in peat
Juglans hindsii, California black walnut (California).	Oct. 15–Nov. 30.....	80	24	28	Do.
Lathyrus sulphureus (California).	July 20–Sept. 1.....	10,000	12	62	Hot water.
Lathyrus strictus (California)	May–June	6,000	16	49	No treatment needed.
Lapidospartum squamatum. broombrush (Arizona, California).	June 15–Sept. 30 ..	315,000	5	66	Do.
Lespedeza sericea (cultivated in California).	Seeds should be purchased from dealer.	210,000	6	63	Native of China. Scarification. Commercial seed is usually scarified.
Lithocarpus densiflora, tanoak (California).	Sept. 20–Nov. 1	110	22	78	Germination in peat.
Lonicera hispidula, California honeysuckle (California).	Sept. 15–Oct. 15.....	27,000	54	20	1 month's stratification
Lotus americanus, American deervetch (California, northeast to Minnesota, southeast to Texas).	June 1–July 15	113,000	3	90	Scarification.
Lotus crassifolius (California, Oregon).	June–July	46,000	19	25	Do.
Lotus grandiflorus (California)	June	141,000	9	6	Do.
Lotus scoparius, broom deervetch (California).	June–August	436,000	6	54	Do.

[2] For California conditions only.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Lotus strigosus (California)	May	603,000	8	52	Scarification.
Lupinus albicaulis (California, Oregon, Washington).	July 20–Aug. 15	38,000	2	68	Freshly collected seeds of the lupines germinate well without treatment. Stored seeds require hot-water treatment.
Lupinus andersonii (California, Nevada, Oregon.)	July 1–Aug. 15	11,000	6	77	
Lupinus arboreus, tree lupine (California).	July–September	9,000	2	38	
Lupinus columbianus (California, Oregon, Washington).	July–August	11,000	3	42	
Lupinus excubitus (California)	June–July	27,000	6	92	
Lupinus formosus (California)	June	19,000	4	93	
Lupinus hirsutissimus (California).	May	23,900	7	61	
Lupinus latifolius (California, Oregon, Washington).	July–August	34,600	4	78	
Lupinus longifolius (California).	May–June	24,000	10	92	
Lupinus stiversii (California)	May 20–July 15	21,000	2	96	
Lupinus succulentus (California).	May–June	13,000	4	85	
Lupinus torreyi (California, Oregon, Washington).	July 20–Aug. 30	59,000	2	30	
Lupinus truncatus (California)	May	57,000	4	32	
Lycium richii (California)	June	1,371,000	12	11	No treatment needed.
Madia elegans, common madia tarweed (California, Nevada, Oregon).	June–July	159,000	106	87	Do.
Medicago hispida, California burclover.	May	142,000	7	12	No treatment needed. Naturalized from Europe.
Melica torreyana (California)	May–June	249,000	141	46	No treatment needed.
Mentzelia laevicaulis, blazingstar (Oregon, east to Wyoming).	Aug. 15–Nov. 30	413,000	15	30	Do.
Mesembryanthemum croceum (grows near coast in California).	June–August	292,000	6	22	No treatment needed. Naturalized from Africa.
Mimulus cardinalis, monkeyflower (Arizona, California, Oregon, east to Utah).	do	22,000,000	16	95	No treatment needed.
Monardella odoratissima (California, Oregon, Washington, east to Utah).	July–September	600,000	29	18	No treatment for fresh seeds. Stratification of stored seeds for 3 months.
Myrica californica, Pacific waxmyrtle (California, Oregon, Washington).	September	22,000	113	60	3 months' stratification.
Nicotiana glauca, tree tobacco (grows wild in California).	June 15–Aug. 1	10,000,000	7	80	No treatment needed. Naturalized from South America.
Oenothera hookeri, evening primrose (California).	July–August	1,400,000	11	70	No treatment needed.
Osmaronia cerasiformis (California).	Aug. 1–Sept. 15	1,800	87	100	2½ months' stratification.

[2] For California conditions only.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Paeonia brownii, western peony (California, Oregon, Washington, east to Utah).	Apr. 20–June 20	2,000	87	42	2½ months' stratification
Parosela schottii	June	13,900	3	99	No treatment needed.
Parkinsonia aculeata, horsebean (used in Arizona for street planting).	May–July	12,000	4	100	Introduced from tropical America. Boiling water treatment.
Pentstemon antirrhinoides, snapdragon pentstemon (California).	May 1–June 15	2,000,000	10	62	No treatment needed.
Pentstemon breviflorus (California, Nevada).	June 1–Sept. 15	5,000,000	32	21	Do.
Pentstemon centranthifolius (eastern Arizona, California, southern Utah).	June 15–Sept. 15	255,000	10	52	Do.
Pentstemon deustus (California, Oregon).	Aug. 1–Sept. 15	496,000	69	100	Do.
Pentstemon heterophyllus (Califiornia).	July 1–Sept. 15	1,000,000	10	34	Do.
Pentstemon newberryi (California).	August–September	1,500,000	59	30	Do.
Pentstemon palmeri (California, east to southern Utah).	June	294,000	30	62	Do.
Perezia microcephala, sacapellote (California).	May 20–June 30	320,000	22	25	Do.
Phacelia californica, rock phacelia (California).	June 12–Sept. 30	368,000	143	65	Do. Stratification beneficial.
Phacelia parryi (California)	June	1,468,000	5	44	No treatment needed.
Phacelia tanacetifolia (California).	May–June	450,000	31	7	Do.
Phacelia viscida (California)	June	2,443,000	10	25	Do.
Philadelphus lewisii, mock orange ("syringa") Idaho, Montana, Oregon, Washington).	September–October	8,000,000	26	52	No treatment needed. Stratification beneficial.
Photinia salicifolia, Christmasberry, toyon (California).	Oct. 15	24,000	10	73	No treatment needed for fresh seeds. Stratification of stored seeds.
Physocarpus (Opulaster) capitatus, ninebark (California, east to Atlantic, north to British Columbia).	July 1–Sept. 15	822,000	67	9	No treatment needed.
Pistacia chinensis, Chinese pistachio (used for street planting in California).	August–September	7,000	13	65	Naturalized from China. Fresh seeds germinate well. Hot-water treatment for stored seeds. Stratification.
Platanus racemosa, California sycamore (California).	June 10–Sept. 15	219,000	135	12	Stratification.
Potentilla (Drymocallis) glandulosa (California, New Mexico, Oregon, Washington, east to South Dakota).	July–September	1,438,000	9	84	No treatment for fresh seed. Stratification of stored seed.

[2] For California conditions only.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [1]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Prunus demissa, western chokecherry (California, Oregon, Washington).	August–September	1,600	101	12	3 months' stratification.
Prunus emarginata, bitter cherry (California, Idaho, Oregon, Washington).	...do	1,800	96	5	Do.
Prunus ilicifolia, hollyleaf cherry (California).	September–October	200	52	24	No treatment for fresh seed. Stratification of stored seed for 3 months.
Prunus subcordata, Pacific plum (California, Oregon).	August–September	450	99	100	3 months' stratification.
Purshia tridentata, bitterbrush (California, Oregon).	July–September	18,000	90	69	Do.
Quercus agrifolia, coast live oak (California).	September–October	200	17	73	Stored between collecting and fall planting in cool room, inspected frequently, and, if warm, spread on the floor. Germinated in deep boxes in peat and sown same fall as collected. Stratification during winter for spring sowing.
Quercus chrysolepis, canyon live oak (Arizona, California, southern Oregon).	do	150	53	56	
Quercus douglasii, California blue oak (California).	August–October	180	31	72	
Quercus dumosa, California scrub oak (California).	June–September	100	27	80	
Quercus durata, leather oak (California).	August–September	100	29	50	
Quercus kelloggii, California black oak (California, southwestern Oregon).	September–October	115	15	95	
Quercus lobata, valley white oak (California).	do	75	41	24	
Quercus wislizenii, highland live oak (California).	do	100	54	40	
Raphanus sativus, radish (throughout the West).	July–November	54,000	4	96	No treatment needed. Naturalized from Europe.
Rhamnus californica, California buckthorn (California, southern Oregon).	September–October	[2] 2,000	22	30	No treatment for fresh seed. Stratification of stored seed.
Rhamnus crocea, hollyleaf buckthorn (redberry) (California).	June–September	70,000	72	60	No treatment needed.
Rhamnus crocea, var. *ilicifolia*, hollyleaf buckthorn (California).	.....do	71,000	98	73	No treatment for fresh seed. Stratification of stored seed for 3 months.
Rhamnus purshiana, buckthorn (California, Oregon, Washington).	September–October	2,000	80	40	3 months' stratification.
Rhamnus rubra (California)	August–September	[2] 3,000	54	16	Fresh seed germinates fairly well. Stratification improves germination

[1] For California conditions only.

[2] Dry fruits each containing two seeds.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Rhododendron californicum, coast rhododendron (California, Oregon, Washington).	August-September	2,000,000	13	90	Germinated in fine soil with generous admixture of screened peat.
Rhus integrifolia, lemonadeberry mahogany sumac (California).	July–October	[7] 8,000	11	84	Sulphuric-acid treatment 4 hours or more, depending on age of the seed.
Rhus laurina, laurel sumac (California).	August–September	90,000	10	32	Hot water.
Rhus ovata, sugar sumac (California).	September–November.	[8] 26,000	18	39	Sulphuric acid treatment 1 to 6 hours, depending on age of seed.
Ricinus communis, castor bean (grows wild in warmer parts of California).	August–November	800	4	78	Germinates well. Originally probably from Africa. Locally naturalized in southern California. Beans poisonous.
Robinia pseudoacacia, black locust (introduced to the West as a street tree).	August–September	20,000	4	80	Hot water. Originally from Eastern and Central United States.
Romneya coulteri, matilija poppy (California).	July–September	600,000	94	20	3 months' stratification.
Rosa californica, California wild rose (California).	August–November	102,000	104	62	Do.
Rosa gymnocarpa, wood rose (California, Oregon, Washington).	September–October	28,000	86	43	Do.
Rosa nutkana (California, Oregon, Washington, east to Utah).	September	30,000	100	50	Do.
Salvia apiana, white sage (California).	June–July	341,000	11	71	No treatment needed. *Should not* be soaked before sowing.
Salvia columbariae, chia (California).	May–August	1,000,000	10	28	
Salvia leucophylla, whiteleaf sage (California).	June–July	304,000	5	54	
Salvia mellifera, black sage (California).	do	467,000	38	36	
Salvia sonomensis, creeping sage (California).	August		95	25	3 months' stratification.
Salvia spathacea (California)	June	27,400	13	26	No treatment needed.
Senecio douglasii, creek senecio (California, Nevada, east to Texas).	June–October	460,000	4	93	Do.
Shepherdia (*Lepargyrea*) *argentea*, silver buffaloberry (California, east to Rocky Mountains).	June–August	18,000	38	78	Do.
Sisyrinchium californicum (California, Oregon).	June	417,000	12	92	Do.

[2] For California conditions only.

[7] Seeds; 3,000 dry fruits.

[8] Seeds or 17,000 dry fruits.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Sitanion jubatum (California, Oregon, Washington).	July–August	64,000	5	90	No treatment needed.
Sorbus sitchensis, western mountain ash (California, Oregon, Washington, east to Labrador).	September	[9] 66,400	50	21	4 months' stratification at 32° F.
Spartium junceum, Spanish broom (cultivated in California).	July–September	30,000	54	14	Hot water. Naturalized from Europe. Drought resistant.
Sphaeralcea ambigua (California east to Arizona).	June	849,000	18	25	No treatment needed.
Staphylea bolanderi, Sierra bladdernut (California).	July–August	13,000	200	16	Sulphuric acid treatment for 1 hour.
Stenotopsis linearifolius, narrowleaf goldenbush (Arizona, California, east to southern Utah).	May–July	233,000	16	24	No treatment needed.
Stipa coronata, porcupine grass (California).	do	119,000	14	64	Do.
Stipa lettermani (California, Colorado, Idaho, Oregon).	June–August	115,000	14	66	Do.
Stipa pulchra, purple needlegrass (California).	May–July	218,000	5	50	Do.
Styrax californica, California snowbell (California).	August–October	[10] 1,000	6	23	No treatment needed. 2 months' stratification beneficial.
Symphoricarpos albus, snowberry (California, Oregon, Pennsylvania, Washington, east to New England).	October–November	[11] 54,000	([12])	([12])	1 hour sulphuric acid, then 6 months' stratification. This valuable erosion-control genus can be easily propagated from cuttings under field conditions. Propagation by seed is difficult.
Symphoricarpos mollis, spreading snowberry (California, Oregon, Washington).	September–October	[4] 18,000	([12])	([12])	
Symphoricarpos rotundifolius (California, east to New Mexico).	do	[4] 16,000	([12])	([12])	
Tanacetum camphoratum (California).	June–August	1,000,000	12	1	No treatment needed.
Tetradymia spinosa (Arizona, California, Oregon, east to Utah).	June	120,000	7	2	Do.
Torreya californica, California nutmeg (California).	September–November.	140	232	92	3 months' stratification.
Umbellularia californica, California-laurel (California, Oregon).	October–December	300	93	41	Do. Fresh seed germinates fairly well in peat.

[2] For California conditions only.
[4] Dry fruits.
[9] Seeds or 6,210 dry fruits.
[10] Seeds or 500 dry fruits.
[11] Seeds or 18,000 dry fruits.
[12] Results are not conclusive.

APPENDIX 1.—*Seed and cultural data for some western plants*—Continued

Species and natural range	Time of seed collecting [2]	Approximate number of seeds per pound	Days between sowing and germination	Highest germination percentage obtained	Treatment and remarks on culture
Uropappus linearifolius (California, east to Nevada, Mexico).	May	216,000	35	71	No treatment needed.
Vaccinium ovatum, box blueberry (California, Oregon, Washington).	August–September	8,000	91	18	3 months' stratification.
Vitis californica, California grape (California).	September–October	[13] 11,000	20	74	No treatment needed.
Wyethia helenioides (California)	August–September	10,000	27	36	Do.
Wyethia mollis, woolly mule-ears (California).	September–October	25,000	34	16	Do.
Yucca whipplei, chaparral yucca (California).	June–September	27,000	9	85	Do.
Zauschneria californica, Mexican balsamea (California).	September–November.	1,000,000	5	68	Do.

[2] For California conditions only.

[13] Seeds or 3,500 dry fruits.

APPENDIX 2.—BOOKS ON WILD PLANTS FOR WESTERN STATES

COULTER, JOHN M.:
1909. New manual of botany of the central Rocky Mountains (vascular plants). Rev. by Aven Nelson. New York, American book company. 646 p.

DAYTON, W. A., ET AL.
1937. Range plant handbook. Washington, U. S. Government Printing Office. (U. S. Dept. of Agriculture. Unnumbered publication.)

JEPSON, W. L.:
1925. A manual of the flowering plants of California. Berkeley, Associated students store, University of California. 1238 p.

MCMINN, H. E., and MAINO, *E.*:
1935. An illustrated manual of Pacific coast trees. Berkeley, Calif., University of California press. 409 p.

MUNZ, P. A.:
1935. A manual of southern California botany. Claremont, Calif., Claremont Colleges. 642 p.

PIPER, C. V.:
1906. Flora of the state of Washington. Washington, Government printing office. 637 p. (U. S. National museum. Contributions from the U. S. National herbarium, vol. 11.)

———, and BEATTIE, R. K.:
1915. Flora of the northwest coast. Lancaster, Pa., Press of the New era printing company. 418 p.

ROSE, J. N.:
1896. Plants from the Big Horn Mountains of Wyoming. Washington, Government printing office. 567–576 p. (In U. S. National museum. Contributions from the U. S. National herbarium, vol. 3, no. 9.)

RYDBERG, P. A.:
1900. Catalogue of the flora of Montana and the Yellowstone national park. New York, Press of the New era printing company. 492 p. (New York botanical garden. Memoirs, vol. 1.)

1906. Flora of Colorado. Fort Collins, Colo. 448 p. (Colorado. Agricultural experiment station. Bulletin 100.)

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1917. Flora of the Rocky Mountain states and adjacent plains, Colorado, Utah, Wyoming, Alberta, and neighboring parts of Nebraska, South Dakota, North Dakota, and British Columbia. New York, The author. 1110 p.

ST. JOHN, H.:

1937. Flora of southeastern Washington and of adjacent Idaho. Pullman, Wash., Students book corporation. 531 p.

TIDESTROM, I.:

1925. Flora of Utah and Nevada. Washington, Government printing office. 665 p. (U. S. National museum. Contributions from the U. S. national herbarium, vol. 25.)

WOOTON, E. O., and STANDLEY, P. C.:

1915. Flora of New Mexico. Washington, Government printing office. 794 p. (U. S. National museum. Contributions from the U. S. national herbarium, vol. 19.)

APPENDIX 3.—LIST OF PUBLICATIONS USEFUL IN PROPAGATION OF PLANTS

BAILEY, L. H., and BAILEY, E. Z.:

1935. Hortus; a concise dictionary of gardening, general horticulture and cultivated plants in North America. New rev. ed. with supplement. New York, Macmillan. 755 p.

BAILEY, L. H.:

1928. The standard cyclopedia of horticulture. New ed. New York, Macmillan. 3 vols.

BEATTIE, J. H.:

1934. Greenhouse construction and heating. Rev. Washington, U. S. Government printing office. 38 p. (U. S. Dept. of Agriculture. Farmers' bulletin No. 1318)

CLEMENTS, EDITH S.:

1927. Wild flowers of the West. With illustrations in color from paintings from life by the author. National geographic magazine 51(5): 566–622. May.

GARDNER, F. E.:

1932. The vegetative propagation of plants. College Park, Maryland. 79–111 p. (Maryland. Agricultural experiment station. Bulletin 335)

GRIFFITHS, DAVID:

1934. Bulbs from seed. Washington, U. S. Government printing office. 32 p. (U. S. Dept. of agriculture. Circular No. 311)

HURST, W. M., HUMPHRIES, W. R., and MCKEE, ROLAND:

1934. The barrel seed scarifer. Washington, U. S. Government printing office. 5 p. (U. S. Dept. of agriculture. Leaflet No. 107)

KRAEBEL, C. J.:

1936. Erosion control on mountain roads. Washington, U. S. Government printing office. 45 p. (U. S. Department of agriculture. Circular No. 380)

KYLIE, H. R., HIERONYMUS, G. H., and HALL, A. G.:

1937. C. C. C. Forestry. Washington, U. S. Government printing office 335 pp. (U. S. Department of agriculture, Forest Service, CCC enrollee training)

LAURIE, ALEX, and CHADWICK, L. C.:

1931. The modern nursery; a guide to plant propagation. New York, Macmillan. 494 p.

MOSES, B. D., and TAVERNETTI, J. R.:

1934. Electric heat for propagating and growing plants. Berkeley, Calif., University of California press. 18 p. (California. Agricultural experiment station. Circular 335.)

MULFORD, F. L.:
1929. Transplanting trees and shrubs. Washington, U. S. Government printing office. 34 p. (U. S. Dept. of agriculture. Farmer's bulletin No. 1591)
SENNER, A. H.:
1932. Greenhouse heating. Washington, U. S. Government printing office. 40 p. (U. S. Dept. of agriculture. Circular No. 254)
WESTOVER, H. L.:
1934. Crested wheatgrass. Washington, U. S. Government printing office. 8 p. (U. S. Dept. of agriculture. Leaflet No. 104)
YERKES, G. E.:
1929. Propagation of trees and shrubs. Washington, U. S. Government printing office. 52 p. (U. S. Dept. of agriculture. Farmers' bulletin No. 1567)

FORESTRY PUBLICATION SERIES

Emergency Conservation Work

No. 1.—MEASURES FOR STAND IMPROVEMENT IN SOUTHERN APPALACHIAN FORESTS.—Prepared by the Staff of the Appalachian Forest Experiment Station, 1933. (Out of print.)

No. 2.—EASTERN FOREST TREE DISEASES IN RELATION TO STAND IMPROVEMENT.—By George H. Hepting, 1934. (Out of print.)

No. 3.—STAND-IMPROVEMENT MEASURES FOR SOUTHERN FORESTS.—Prepared by the Staff of the Southern Forest Experiment Station, 1933. (Out of print.)

No. 4.—CONTOUR-TRENCHES CONTROL FLOODS AND EROSION ON RANGE LANDS.—By Reed W Bailey and A. R. Croft, 1937.

Civilian Conservation Corps

No. 5.—COLLECTING AND HANDLING SEEDS OF WILD PLANTS.—By N. T. Mirov and Charles J. Kraebel, 1939.

No. 6.—TIMBER STAND IMPROVEMENT IN THE SOUTHWEST.—By G. A. Pearson. (In preparation.)

No. 7.—REFORESTATION IN THE SOUTHWEST.—By G. A. Pearson. (In preparation.)

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